SASKATCHEWAN RESEARCH COUNCIL

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27TH ANNUAL REPORT 1975

THE RESEARCH COUNCIL ACT. 1965. Clause 21. in part. directs that:

1. The Council shall on or before the last day of February in each year submit to the Lieutenant Governor in Council a report of its proceedings and transactions during the next preceding calendar year. which report shall contain such particulars as the Lieutenant Governor in Council may prescribe.

2. Every report shall forthwith be laid before the Legislative Assembly if then in session or. if it is not in session. within fifteen days after the opening of the next session.

Regina. February 15. 1974

TO THE HONOURABLE S. WOROBETZ

Lieutenant Governor of the Province of Saskatchewan

MAY IT PLEASE YOUR HONOUR:

The undersigned presents herewith. for your consideration. the report of the Saskatchewan Research Council for the year ended December 31. 1973.

Respectfully submitted.

Gordon MacMurchy. Chairman
Saskatchewan Research Council

PLEASE ADDRESS CORRESPONDENCE TO:

Saskatchewan Research Council
30 Campus Drive
Saskatoon. Saskatchewan
S7N 0X1

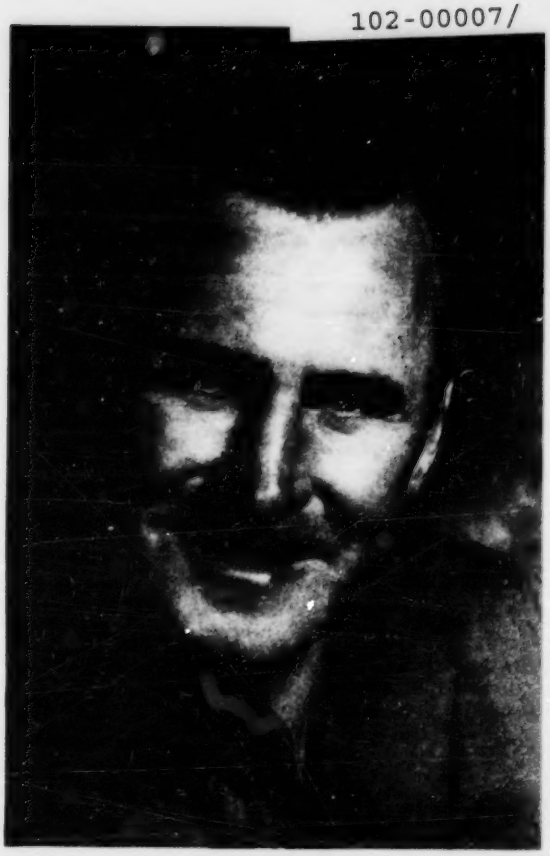
102-00007/

1973 IN REVIEW

The Saskatchewan Research Council in 1973, for the first time, matched its provincial grant with revenue from contracts, grants and other remunerative activities, grossing approximately two and one-half million dollars.

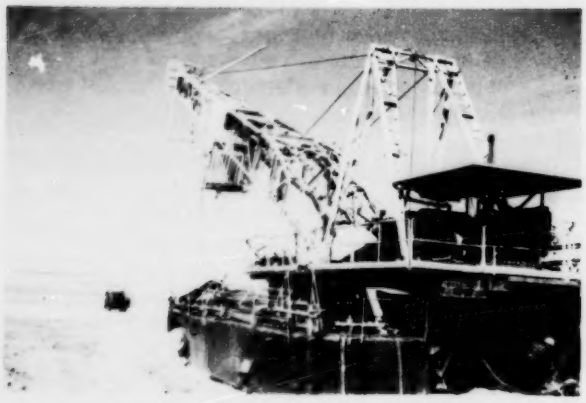
This illustrated review section highlights some new activities or novel aspects of continuing projects. Fuller details of the program of the laboratories and staff follow in the divisional reports.

Policies aimed at greater development of secondary industries in Saskatchewan have brought about changes in the Saskatchewan Research Council's program. Direct results from this policy include the sponsorship of industrial research on some 10 projects by the Saskatchewan Department of Industry and Commerce. The fields of interest range from the brine shrimp industry to recycling of waste materials to a clay products complex. About $200,000 is involved in the various investigations.



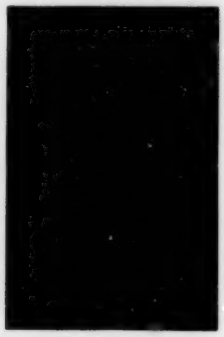
THE HON. GORDON MacMURCHY

SASKATCHEWAN RESEARCH COUNCIL MEETING. *June 26, 1973. Front (left to right) B. W. Currie, E. R. Olson, T. P. Pepper, W. H. Horner, J. W. T. Spinks, C. R. Webster, J. Roe Foster; Back (left to right) J. B. Mantle, A. B. Van Cleave, J. G. Wotherspoon, R. N. H. Haslam, G. C. Mitchell, J. H. Archer; missing from the picture Hon. Gordon MacMurchy, G. Gartner, C. A. L. Hogg, R. H. D. Phillips, K. O. Saddlemyer, W. K. Setter, R. V. Tomkins.*



OIL FIELD EQUIPMENT *(right) was used to develop a water well in the Judith River formation at a depth of 1,473 feet near Frontier (left) in the dry southwestern corner of the province. This technology, coupled with freeze desalination when required, promises a new source of drinkable water for a large area.*

DRINKING WATER *can be produced from saline water by freeze desalination. This process utilizes free refrigeration of prairie winters to separate pure water from brine. This ice mound, near Bruno, is the product from an SRC test unit.*



COMPUTER-ASSISTED CARTOGRAPHY *is being developed and refined by a group of engineers and computer scientists in the Electrical Engineering Department, University of Saskatchewan, Saskatoon. Cartographic data, in digitized form, can be recalled and set up on an interactive display by the operator (left). The interactive display, as seen by the operator, can be seen on the right. SRC assists this work through Council's university grants program.*

This increased work with the Department of Industry and Commerce illustrates the Council's concern to be of increased usefulness to the various departments and agencies of the provincial government. To facilitate this a direct telephone line to Regina was installed in December, 1973.

As a consequence of greater emphasis on secondary industry certain aspects of the Council's ongoing program dealing with optimum utilization of the province's resource base have been selected for special attention. In view of the energy crisis, a joint federal-provincial study of Saskatchewan's estimated 13,000,000,000-ton lignite reserve is of particular significance. The study, co-ordinated by the Council, has a proposed 3-year duration. Two years work on assessment of lignite resources have already been completed.

The preservation and enhancement of our fragile prairie environment has been a continued concern of SRC. New industrialization brings new pressures on the environment or accentuates old ones. Odours from feed lots are becoming a more pervasive problem as the livestock industry intensifies. The Council, assisted by the Saskatchewan Department of Agriculture and the Horned Cattle Check-off Fund, have proposed measures to ameliorate this problem.

Many aspects of the industrial scene are handled at the Council. A technical inquiry from a sodium sulphate producer concerning the design of shipping pallets resulted in use of a more appropriate unit for the job at hand. Consequently, breakage and lost orders were reduced, a Saskatchewan-based operation now fabricates $10,000 to $15,000 worth per year of shipping pallets for the sodium sulphate producer and the sodium sulphate producer realizes a financial gain of $70,000 annually.

Small industry in Saskatchewan can, in many cases, qualify for federal financial assistance to do research and development work concerning their products. SRC has played a role in obtaining over $223,000 for Saskatchewan industrial research assisted under the various federal programs. Further applications are pending.

Sophisticated geochemical methods have been used to establish background levels of copper, lead, zinc, uranium, manganese, iron and other elements. These techniques were utilized for the Department of Northern Saskatchewan. Trends toward higher concentrations of these elements are indicative of possible economic mineralization.

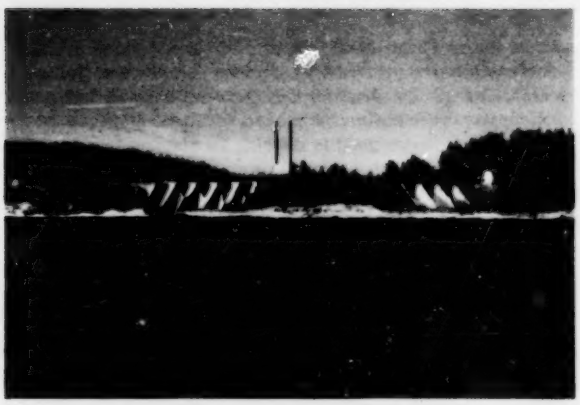
A deep well at Frontier, tapping the Judith River Formation, promises a new water source for the southwestern part of the province. Saline groundwater in this area can probably be improved in quality by freeze desalination, a process in which the fact that pure water freezes and melts at a higher temperature than salt water allows their separation. Cold prairie winters supply the capacity for refrigeration at no cost.

Spraying of herbicides, such as 2,4-D, must be optimized in terms of application technology in order to achieve most effective weed kill patterns and to minimize pesticide loads in the environment. A major program for this type of study in the prairie region is a joint venture involving SRC and the Canada Department of Agriculture. Spray application patterns from helicopters and conventional aircraft have been under study during the past year.

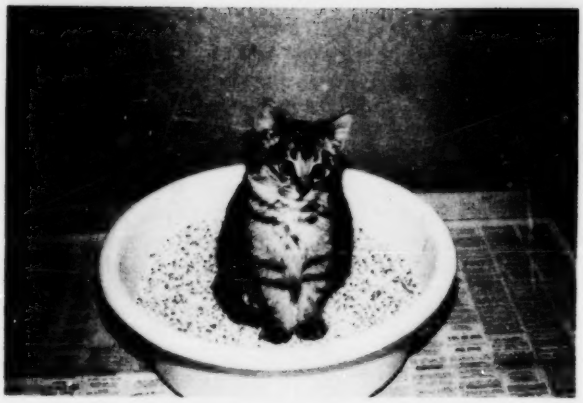
For a number of years studies concerned with groundwater have been under way at SRC. These groundwater studies, financed in part under the ARDA program, enabled SRC to undertake the task of accrediting drillers for the Saskatchewan Department of Agriculture's program of financial assistance for farm water well exploration.

As well as providing a higher level of assistance to Saskatchewan government and industry during the past year, the Council is meeting some success in selling its skills outside the province. SRC has increased its revenues through contractual sources by undertaking various tasks for the Department of Supply and Services under the federal government's make-or-buy program.

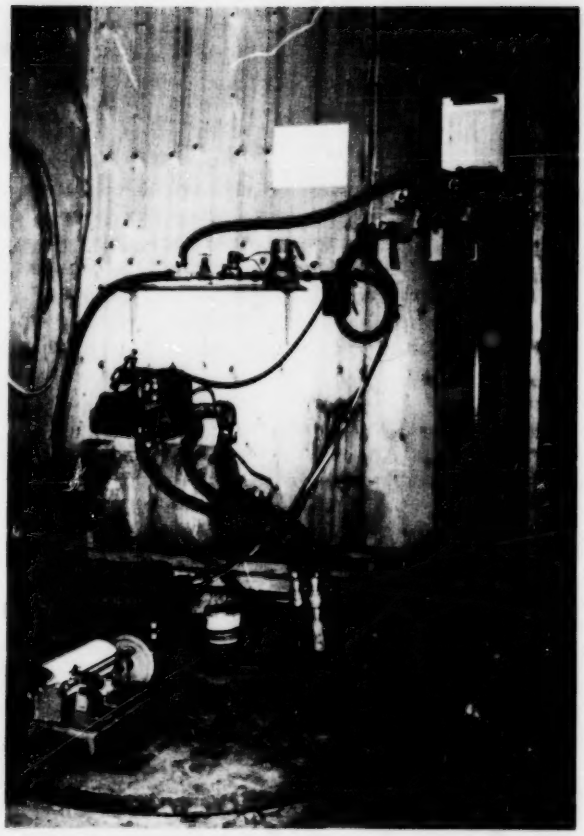
Co-operation between scientific groups in order to increase the breadth of expertise and to avoid unnecessary duplication of expensive facilities is a continuing Council policy. Last year formal or informal co-operative arrangements were maintained between SRC, the University of Saskatchewan, the Prairie Regional Laboratory of the National Research Council, and the Canada Department of Agriculture. A variety of activities, ranging from slurry pipelining to pelletizing of peat moss, are involved.



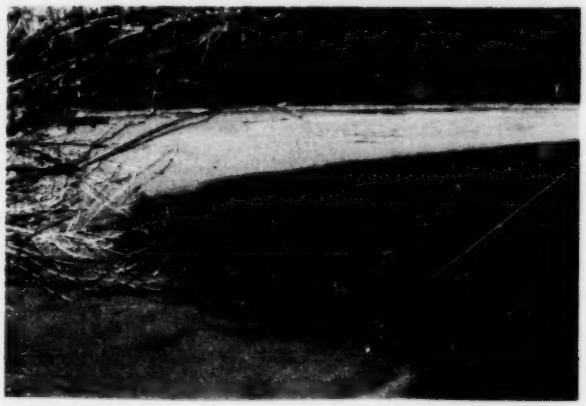
WHITE SAND DAM, near Southend, is in the area where proposed development of the Churchill River project could effect the environment. SRC is carrying out investigations of some aquatic environment aspects under contract from the Department of Natural Resources.



NEW CLAY PRODUCTS **will assist Saskatchewan industry in capturing a larger share of the market for this bountiful resource. Animal litter, now imported from the United States, is a subject of investigation at SRC.**



WATER WELL DETERIORATION **is often experienced in large-diameter wells as earth materials collapse into the well following years of use. At this Asquith dairy farm water level and water consumption are measured and sand is filtered from the pump line. The study is designed to develop techniques for improved operation of large-diameter wells.**



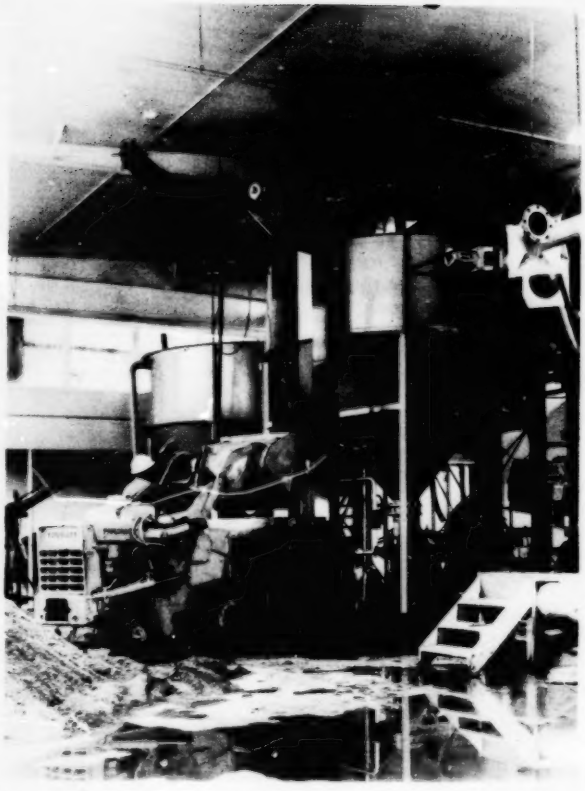
ALGAE-INFESTED WATERS **can be improved by precipitating the algae with fly ash, a waste product from the province's thermal power stations, preliminary SRC research indicates.**

NATIVE HANDICRAFTS *are easier when modern technology is used in hide preparations. A group from the Duck Lake Handicraft Society is seen employing SRC-developed methods in the Council's facilities.*

BIOLOGICAL INVENTORY *of lake bottom studies is an activity area only recently entered by SRC. Here summer assistants Doug Kyle (left) and Ron Horn are filtering sediments collected during a background study of the Churchill River system.*

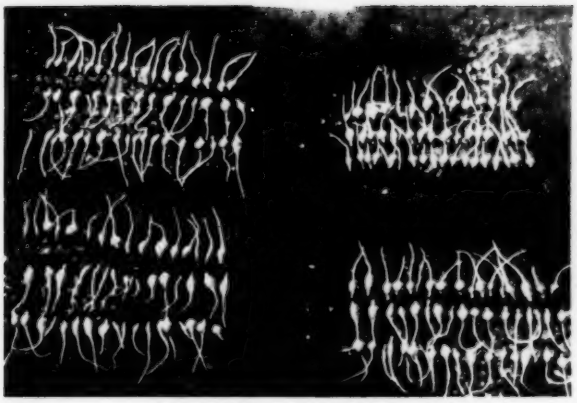
IRON BACTERIA, *which prove troublesome in many wells, are a subject of investigation at the University's Regina campus. Mrs. Annette McCann is shown carrying out a test to determine the minimum temperature at which these bacteria will grow. These studies receive financial assistance from SRC.*

SPECIAL BURNERS *are used to fuse samples with chemicals prior to determining the uranium content. The samples, collected from lake bottoms, overburden and rock outcrops in northern Saskatchewan, are analyzed for 14 elements both common and rare as part of a double pronged attack on the problems of locating economic mineral deposits and improving exploration methods.*

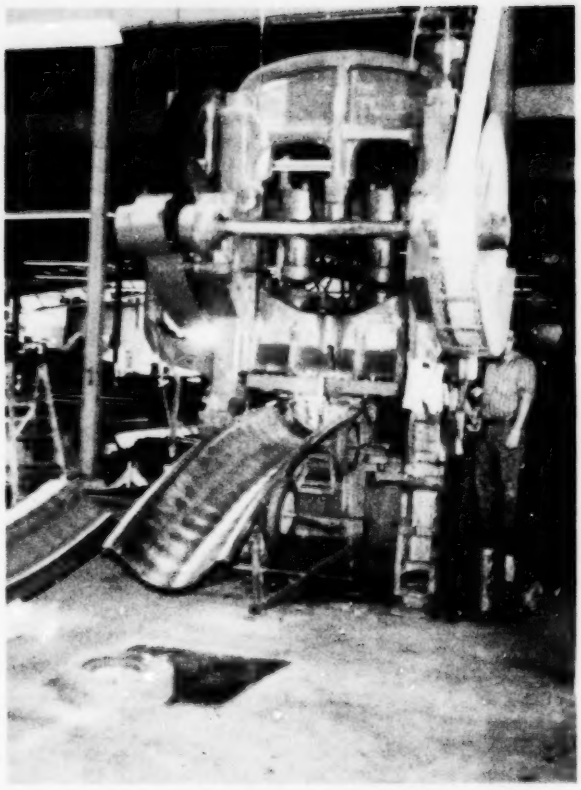


POTASH MOVEMENT *by slurry pipeline was a subject of investigation at SRC's pipeline transportation facility. Work at this laboratory has received major support from the Canadian Transport Commission through contractual programs.*

INDUSTRIAL MINERALS, *such as clay, are subjects of study by the Saskatchewan Research Council. Intensive exploration of clay resources in the Big Muddy valley has been undertaken by the Council.*

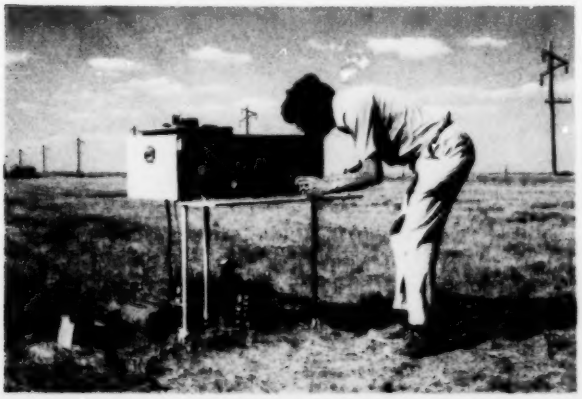


PEAT MOSS PELLETS are useful to gardeners as an additive to soil. As the pellets break up they release natural growth hormones. Untreated radishes (upper right) are smaller than those raised in various soil-peat moss mixtures.

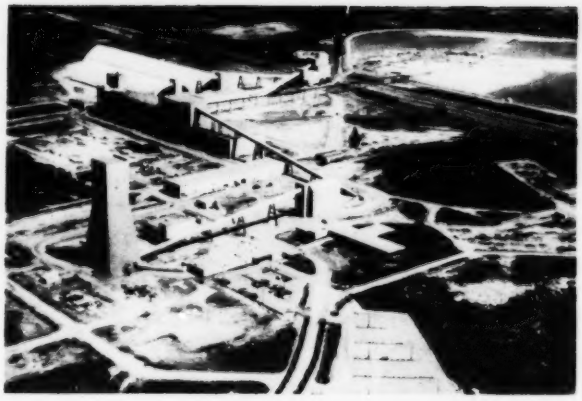


PLANT LAYOUT is among the free and confidential services offered by SRC's industrial engineering group. Machines such as this high speed corrugator were relocated to improve the operations of a client company. The industrial engineering service receives financial backing from the National Research Council.

PESTICIDE DRIFT from spray equipment can be minimized by meticulous equipment design and careful operating procedures. John Maybank prepares monitoring equipment to test spray performance during a field trial. This work is supported in part through a contract with the Canada Department of Agriculture.



WASCANA CREEK area (left) was the scene of a major field trip during the 1973 meeting of the Geological Association of Canada. The 600,000-year-old volcanic ash (right) deposit was discovered by D. L. DeLorme and described by E. A. Christiansen of SRC. Council scientists were key figures among the organizers and field guides for the G.A.C. meeting.



ENVIRONMENTAL MONITORING around potash mines is carried out under a program co-ordinated by SRC. Measurements of salt dust in the air, and in soil and plant samples, are taken within a six-mile radius surrounding each operating refinery. The field work is carried out by the Saskatchewan Institute of Pedology while the Saskatchewan Mining Association and the Saskatchewan Department of the Environment provide a share of financial support.

CROP SPRAYING from aircraft is being investigated by SRC in order to optimize application techniques. As well as assisting farmers, such optimum spray techniques reduce the pesticide load in the general environment.

MEMBERS OF THE SASKATCHEWAN RESEARCH COUNCIL

The Honourable Gordon MacMurchy, Chairman
W. H. Horner, Vice Chairman
W. K. Setter, Secretary
J. H. Archer
B. W. Currie
J. Roe Foster
G. Gartner
R. N. H. Haslam
C. A. L. Hogg
J. B. Mantle
G. C. Mitchell
E. R. Olson
R. H. D. Phillips
K. O. Saddlemyer
J. W. T. Spinks
R. V. Tomkins
A. B. VanCleave
C. R. Webster
J. G. Wotherspoon

EXECUTIVE OFFICERS OF THE COUNCIL'S STAFF

Director	Dr. T. P. Pepper
Administrative Officer	Mr. R. E. Melvin

Division Heads

Chemistry	Dr. Brad H. Gunn
Engineering	Dr. W. H. W. Husband
Geology	Dr. R. G. Arnold
Industrial Services	Mr. I. S. Evans
Physics Division	Dr. J. Maybank

PROCEEDINGS OF THE COUNCIL

Membership of the Council increased from 18 to 19 during the year up to date of writing (November 14) with the addition of Mr. K. O. Saddlemyer. The Research Council Act allows for a maximum membership of 21. Mr. J. G. Wotherspoon and Dr. J. H. Archer, whose terms of office had expired, were reappointed. Dr. G. Gartner was appointed to serve out the unexpired term of Dr. D. H. A. Prefontaine. The terms of office of the following nine members will expire November 20, 1973: W. H. Horner, W. K. Setter, B. W. Currie, J. Roe Foster, R. N. H. Haslam, E. R. Olson, R. H. D. Phillips, A. B. VanCleave, and C. R. Webster.

The Council met three times during the year; on February 21 in Regina, June 26 in Saskatoon and November 14 in Regina. The main business of these meetings was to receive the reports and discuss recommendations of the Appointments, Forward Planning, and Technical Committees.

Members of the Technical Committee during 1973 were Dr. B. W. Currie, Chairman, Mr. W. H. Horner, Mr. E. R. Olson, Dr. A. B. VanCleave, and Mr. C. R. Webster (from June 26th). The Committee held meetings on February 14, March 28, September 28, and November 9 to carry out its regular duties which are to oversee the work program, to recommend grants-in-aid of University Research, and to select the applicants who are to receive Province of Saskatchewan Graduate Research Scholarships.

Members of the Appointments Committee were Mr. E. R. Olson, Chairman, Mr. G. C. Mitchell, Dr. J. W. T. Spinks, and Dr. T. P. Pepper. Committee meetings were held January 15, May 4, September 28, and November 5. The regular duties of the Committee are to make recommendations to the Council on matters relating to the staff, including establishment of positions, appointments and salaries. Two new positions were established; one position of Assistant Research Officer in the Chemistry Division and filled by Dr. W. W. Sawchyn; and one position of Research Council Officer II in the Administration Division to be filled by a staff member to become Head, Financial Services. The following staff members resigned during the year: Mrs. P. K. Colbourne, Messrs. D. Bailey, G. Bland, S. Thomas, and H. Schmidt. The following staff members were reclassified from temporary status to vacant established permanent positions: Mr. G. Lakshman to Assistant Research Officer in the Engineering Division, Miss J. Morin to Clerk Regulatory II in the Division of Industrial Services, and Mr. W. Rielkoff to Supplies and Services I in the Administration Division. Mr. G. Bromberg retired and was honoured at a staff luncheon March 29, at which Council's appreciation of long and useful service was expressed. Mr. B. Pope assumed the responsibilities of Shop Foreman vacated by Mr. Bromberg.

Members of the Forward Planning Committee were Dr. A. B. VanCleave, Chairman, Dr. B. W. Currie, H. D. Phillips, R. V. Tomkins, J. G. Wotherspoon, I. S. Evans, and Dr. T. P. Pepper. At its only meeting during the year on February 12, the Committee discussed the scope of the operations of staff and laboratories, received and subsequently distributed to Council an account of "Technical Competence of the Saskatchewan Research Council Scientific Staff".

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REPORT OF THE CHEMISTRY DIVISION

Brad H. Gunn, Head

INTRODUCTION

The objectives of the chemistry division have undergone further revision during the year. This has led to increased activity on projects designed to assess the present status of our environment and to investigate some current environmental problems.

The division has become increasingly aware that industry in Saskatchewan requires technical assistance and is endeavoring to provide this assistance where possible. It is particularly interested in providing information on processes which will permit one or more stages of processing a primary product and hence reverse the general trend of exporting raw materials from our province. One of the province's aims is to supply our own needs as much as possible with indigenous materials. In a province as large as Saskatchewan a further consideration has to do with the use of resources within the province. Where possible, resources available in the north should be used in the north and conversely those indigenous to the south should be used in the southern part of the province.

There has been a conscious effort in the chemistry division to help those who are endeavoring to initiate industry in the province. Assistance has also been provided to those in industry who are experiencing difficulties. Often, short term contracts are undertaken for this purpose.

Industrial Minerals

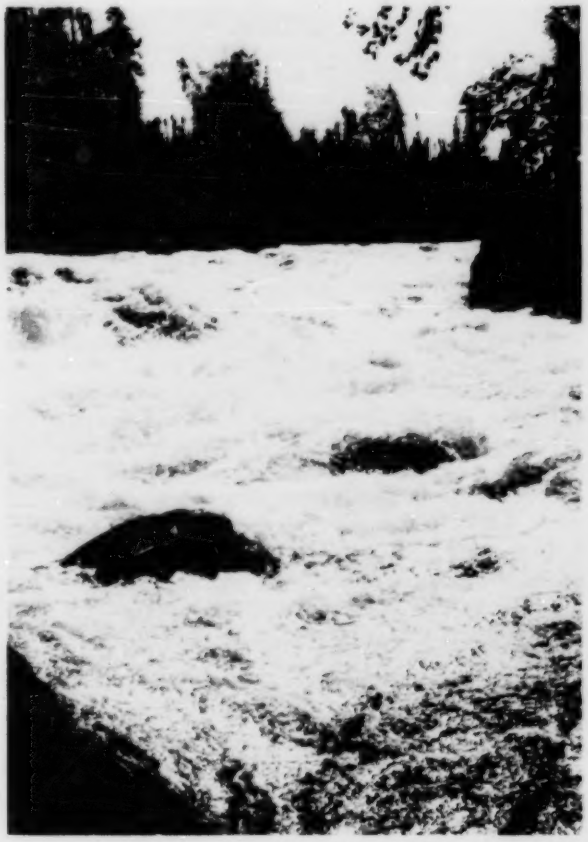
With a background on beneficiating potash ore, assessing flotation reagents and dealing with anticaking problems, we remain available for consultation on day to day problems encountered by the potash producers. We answer inquiries, from time to time, on conversion of potash (as KCl) to other potash chemicals and from the number of inquiries, it is evident that the demand for non-chloride sources of potash is increasing. At present potassium sulphate is being imported for potato and tobacco producers in Ontario. There has not been the anticipated increase in world production of either potassium sulphate or potassium nitrate. The opportunity for producing either is still available and the location of production facilities in Saskatchewan appears logical. The bench scale work has been performed, the processes appear satisfactory, the raw materials are locally available and the higher priced product is more capable of coping with the freight rate barrier. In the meantime our project on conversion of KCl to other potash fertilizers is being shelved.

Our relations with the sodium sulphate industry are fairly similar to those with the potash industry. When there are processing difficulties we may be called in on a consulting basis. We perform routine chemical analysis, as well as provide analysis of trace contaminants when the customers make particular demands on the producers.

Environment

Our first major contract in the area of biology was completed in September with the submission of a report to Gulf Minerals Canada Ltd. on the results of an *Environmental Survey of Wollaston Lake*. This contract has been followed by a similar contract with the Saskatchewan Department of the Environment for studies on the Churchill River system. With personnel available for field work in the summer and backup lab facilities in biology and chemistry in Saskatoon, the Saskatchewan Research Council has developed a new capability which we anticipate will benefit both industry and government in Saskatchewan.

Some of our studies, with a direct bearing on the environment, are under contract with the Saskatchewan



AQUATIC ENVIRONMENT, such as this section along the Churchill River system, are investigated for chemical and biological quality by SRC field teams.

Department of Industry and Commerce; one such study is included under the broad title *Treatment of Wastes by Extraction and Recycle*. Another environment contract on the *Control of Odours in Intensive Livestock Operations* is being funded jointly by the Horned Cattle Check-off Fund and by the Saskatchewan Department of Agriculture.

Plant growth effects resulting from applications of leonardite (an oxidized lignite associated with lignite), or extracts from leonardite have been assessed in plant pots and in field plots. The increased rate of root formation resulting from the addition to water of small concentrations of humates (0.1 per cent) extracted from leonardite are spectacular. Similarly, as noted in last year's annual report, there is a good response to leonardite when it is applied to field plots. The results of these findings have stimulated interest among those undertaking an experimental program on re-establishing plant growth in the strip-mined coal areas in southern Saskatchewan. One of the most attractive aspects of the proposal is that leonardite is available in the area where it would be used. Leonardite usually occurs with lignite or above the lignite seams and could be stockpiled for use as a soil conditioner, and a plant growth stimulant applied in conjunction with appropriate fertilizers for regeneration of plant growth in areas close to its source.

Peat moss, which is also abundant midway north in the province (Saskatchewan has 90 per cent of Canada's peat resources), has many of the same constituents as leonardite. Peat moss is a relatively undeveloped resource in Saskatchewan partly because the season for harvesting is short but more particularly because it is bulky and hence expensive to ship to markets at considerable distances, e.g. California. Reducing the volume of peat moss is achieved by pelletizing. Recent experiments using pelletized peat moss have been very successful in plant pot and field trials. It is likely that the pellets would be capable of penetrating larger markets at greater distances from source as a result of greater economies in handling and shipping. It is also believed that a local market close to the source would be expanded. The present practice of planting trees in tubes would probably be more successful if peat pellets containing fertilizers were incorporated with the tree seedling. This program will be expanded in the next year.

Natural Products and Organic Chemistry

There has been a major change in emphasis in this area of study. Long range programs have been dropped or modified so that they can be given short term objectives (six months - two years). Closer relationships with private and public organizations have been developed. Some of these contacts have led to projects on new and improved methods of processing various agricultural products. A contract completed within the year, provided North Eastern Alfalfa Dehydrators Research Association with a rapid method of performing chemical analysis for xanthophyll in alfalfa (xanthophyll content is the basis of a sales specification for the Japanese market for dehydrated alfalfa being produced in Saskatchewan). A more recent contract on agricultural by-products has just been written and initiated.

Extraction of protein from alfalfa leaves is a popular activity in many parts of the world. We are presently engaged in assessing some of the processes and endeavoring to adapt them to our needs in Saskatchewan. Mechanical methods have been used to separate dried alfalfa (or dehydrated alfalfa) to yield a leaf concentrate containing greater than 30 per cent crude protein and less than 12 per cent fibre. Other considerations have to do with the digestibility and quality of the leaf protein. It is also necessary to investigate the possible toxic effects arising from the presence of saponins.

The separation of leaf protein from fresh, undried alfalfa is not a new concept. It is, however, difficult to justify a processing plant to accommodate a short growing season and an even shorter period of time when suitable fresh alfalfa is available in Saskatchewan. The economics of operating a plant using undried alfalfa would be improved if a satisfactory method of storing fresh alfalfa could be found. One of the methods of storing alfalfa is to ensile it by conventional procedures. What remains to be determined is the effect of ensiling on protein, carotene, fibre saponin, etc. The quality, quantity and extractability of the protein from silage are being evaluated at the present time.

Leather Tanning

Small tanneries, possibly operated, managed and owned by Indian or Metis people, are required to produce leather of a quality similar to the traditional Indian, smoked, tanned leather. At the present time the leather crafts of the native people are in jeopardy because there is a shortage of suitable leather. The traditional tanning skills are being lost and are not popular in any case because of the time, labor and nature of the operation. The object of the tanneries would be not so much to provide jobs in a tannery as to provide leather for an expansion in production of moccasins, mitts, jackets and other articles with a sales potential.

SERVICE FUNCTIONS

Carbon-14, Tritium Dating

Human bones, at first mistaken for moose bones, were discovered in a gravel pit in the Interlake region near Eriksdale, Manitoba. The bones of an adult human male were discovered more or less *in situ*. A corner-notched projectile point imbedded in the proximal end of the left femur was of considerable interest, though it was not the cause of death since bone growth around the point indicated survival after this incident. The point was identified as a Pelican Lake type which indicated that burial probably occurred in the period 1000 B.C. to 200 A.D. Detailed examination of the area indicated a small camp site. The carbon-14 dating laboratory at the Council placed the age of the bone at 1410± 95 B.C.

The dating facility at the Council is jointly sponsored by the National Museum of Man and the Saskatchewan Research Council. The very low activity of ancient samples requires very sophisticated counting equipment. It is only recently that all four channels of a counting assem-

bly installed in 1972 have become completely operative. On the assumption that three out of four channels are operative on a full time basis, hence allowing for 25 per cent down time, the facility is capable of meeting the requirements for dating in Canada and thereby assists in unfolding exciting bits of information from the past.

The amount of tritium in precipitation has been monitored at Saskatoon since 1958. There are wide seasonal fluctuations in the amount of tritium in the precipitation. During the post atomic bomb era there were years with particularly high average values for the tritium radioactive isotope of hydrogen in precipitation samples. As water ages the radioactivity of the isotope reduces rapidly. (The half life period for tritium is just over 12 years.) The difficulties of using tritium values in a hydrological program arise from the eratic fluctuation in the tritium activity over the past two decades and the unavoidable mixing of new and old water in a hydrological system. In theory, a built-in tracer should be invaluable for quick answers in assessing recharge in drainage basin studies. In practice, the magnitude of the uncertainties preclude accurate assessments and provide only qualitative data.

Analytical Service

As a greater variety of chemical analyses are required and as new lower detection limits are expected, it becomes essential to indulge in the use of more sophisticated equipment. Recently, we have assembled an auto-analyzer from a variety of components for the purpose of analyzing NO_2^-, NO_3^-, NH_4^+ and $PO_4^=$ at the parts-per-billion level.

New procedures or modifications of older ones are constantly under review both for routine and for more exotic analysis. During the year the larger analytical programs were on lignite and water. To meet the seasonal pressure on our regular analytical staff, four summer students were taken on for a four-month period. There were also a large number of a large variety of samples from provincial industries — potash, sodium sulphate and smaller industries. Non-routine analyses have been performed for a large number of outside agencies such as the Prairie Regional Laboratory of NRC, Saskatchewan Soils Survey Lab and the University of Saskatchewan Sanitary Engineering Lab. Much of this work is performed on a reciprocal exchange basis. It would be an oversight if the co-operation of various campus agencies and the University of Saskatchewan were not acknowledged at this time. Often they have facilities which we cannot match without excessive expenditures for equipment.

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RESEARCH
COUNCIL

REPORT OF THE ENGINEERING DIVISION

W. H. W. Husband, Head

INTRODUCTION

Staff completed the installation of large scale equipment to demonstrate the spray freezing method of desalination of groundwaters at four locations in Saskatchewan. Natural refrigeration is used to freeze the water and remove the salts. Preliminary results show that the method will succeed even under mild winter conditions.

A team of experts studying the transportation of solid materials in water, through pipelines, completed a three year contract with the Canadian Transport Commission on schedule in September. It has presented the results in eight reports. Engineering data are available to design long distance pipelines for limestone, iron concentrates, potash, certain coals and some types of tailings. The Canadian Transportation Development Agency has awarded the division an 18 month contract to study the transport of coal in oil through pipelines.

The ceramics laboratory has completed a very active year working on industrial contracts. Some projects had to be deferred. Estevan Brick is selling, in the United States, considerable quantities of a white facing brick which this laboratory developed.

At the request of the Saskatchewan Department of the Environment, staff studied the use of waste waters from sewage treatment systems to irrigate crops. The division prepared a plan to study the potential problems such a disposal method might create with Saskatchewan soils.

The hydrology group successfully completed the development of a simple, yet accurate, method of measuring peak flow rates and the total amount of water available from a very small watershed during spring runoff.

Good Drinking Water

The division has been developing a method of improving the drinking qualities of the various groundwater supplies in the settled areas of Saskatchewan. The quality can be improved by removing the dissolved salts usually present in groundwater. The object is to develop a method which is cheap enough to be used by farmers, hamlets, villages, towns and perhaps cities.

Existing methods and current development work in other parts of the world have been reviewed. Most research on water desalination has emphasized the development of sophisticated plants producing millions of gallons of water per day. If these plants are scaled down to a size suitable for use in rural Saskatchewan, the cost of producing water becomes very high because the equipment is complex and skilled operators are required. Therefore, an unconventional method which takes advantage of Saskatchewan weather conditions has been developed. The unlimited natural refrigeration available during a normal Saskatchewan winter can be used to freeze groundwater in three different ways to remove the dissolved salts. They are reservoir freezing, layer freezing and spray freezing. Each way has advantages for different circumstances.

Reservoir freezing involves freezing brackish or saline water naturally in a shallow pond or reservoir during the winter. Three-quarters of the dissolved salts collect in the water remaining beneath the ice. In the spring this water is pumped away. The ice melts and is stored for use during the year. The process is very simple and produces 17 gallons of fresh water per square foot of ice surface from a three foot thickness of ice.

Layer freezing is a process in which a block of ice is built up by freezing layers of brackish water daily on top of previously frozen ice, much in the way that a skating rink is flooded. When the ice begins to melt in the spring, most of the salt appears in the first melt water and is discarded with it. The remaining ice melts to produce fresh water which can be stored for use throughout the year. About 70 per cent of the original groundwater can be recovered as fresh water by this process. More than 60 gallons of fresh water per square foot of ice surface can be obtained under Saskatchewan winter conditions.

Spray freezing is a process which simply sprays water over an area of land to build up a large pile of ice during the winter. In the spring most of the salts leave the ice pile in the first meltwater and are discarded. The remaining ice melts to produce fresh water for use during the remainder of the year. Experimental results and economic calculations indicate that spray freezing would be the simplest and cheapest method to use in Saskatchewan.

During the winter of 1972-73, five spray freezing trials were made. One near Saskatoon used water containing 3,200 parts of dissolved salts per million parts of water (ppm), which were mainly sodium sulphate. Two near the town of Bruno used groundwater containing 2,500 ppm of the salts which were mainly calcium and magnesium sulphates, and two near the village of Blucher used groundwater containing 3,300 ppm of the salts which were primarily sodium sulphate. At each location one of the sites was lined with a butyl rubber membrane so that the meltwater could be measured accurately.

The quantity and purity of the water recovered varied from site to site because of the various experimental factors involved. Even though the Saskatchewan winter was an extremely mild one during 1972-73, in all cases at least 50 per cent of the salty waters was recovered as relatively

fresh water suitable for domestic use. Mounds of ice as high as 50 feet were obtained and the operation was simple.

Four additional sites for spray freeze desalination were constructed late in 1973. Two of the sites are on a farm near Armley, north of Tisdale, where the groundwater has 4,000 ppm of dissolved salts which are mainly sodium chloride. The remaining sites are at the village of Frontier, southeast of the Cypress Hills, where the climate is milder and where the groundwater has 1,800 ppm of dissolved salts which are mainly sodium bicarbonate. As a result of this construction, spray freezing tests are being carried out at five locations in Saskatchewan during the 1973-74 winter. The results will be used to establish the technical and economic feasibility of this method of groundwater desalination for most types of groundwater and climatic conditions which exist in southern Saskatchewan.

The results of the groundwater desalination experiments obtained so far demonstrate that freeze desalination is a practical method of producing potable water where other water supplies are not available. Although Canada has an abundant supply of fresh water, in much of the semi-arid area of western Canada, however, brackish groundwater is the only dependable, well distributed supply. Generally, the density of human settlement is low and is quite uniform throughout this area, hence a system for distributing potable water would be very expensive. Consequently, 45 per cent of the Saskatchewan people living in communities with populations of 10,000 or less use water supplies containing more than 1,000 ppm dissolved salts. The provincial standard, where costs are not prohibitive, is 600 ppm dissolved salts. Twenty per cent of these Saskatchewan people are using water worse than the toleration limit of 1,500 ppm dissolved salts, while in a few communities the salinity of the water supply approaches 4,000 ppm.

Moving Solid Materials by Pipeline

The division has investigated thoroughly the transportation of materials such as potash and coal in pipelines. The objective is to develop an inexpensive method of moving large amounts of solid materials over long distances. Considerable expertise and remarkable facilities for such studies have been acquired at very little cost to the province. Currently, a comprehensive program is being financed by the federal government and the division is using the program to accumulate as much information as possible on Saskatchewan materials.

Solid materials are transported through a pipeline by mixing the crushed solids with water, brine or oil in a mixing tank and then injecting the resulting mixture into the pipeline by means of a pump. These mixtures are called slurries and can contain as much as 70 per cent solids and 30 per cent liquids by weight and are moved through the pipeline at velocities of 3.5 to 5 miles per hour. If material is to be moved over long distances, additional pumps are needed every 50 miles along the pipeline to keep the slurry moving at these velocities.

At the end of September the division completed a three-year contract with the Canadian Transport Commission (CTC), and the Transportation Development Agency to obtain, through full scale tests, the engineering information necessary to design long distance pipelines for Canadian commodities such as coal, potash, limestone, mine tailings, sands, and iron ores. The results have been compiled in a series of eight reports which are available through the CTC. This is the first time any organization has carried out a study with such a wide range of materials and in such detail.

The reports summarize the experimental data obtained when the various commodities were pumped through pipelines of different diameters varying from two inches to 12 inches. The data show the influences which the slurry velocity, the percentage of solids in the slurry, the particle sizes and the pipe diameter have on the energy required by the pump.

In mountainous terrain it is necessary to establish maximum permissible pipeline slopes to ensure that slumping or sliding of the solids does not occur when the pipeline is shut down. Simple experiments were carried out to determine the slopes at which various materials would start sliding at the pipe wall. During the course of these experiments, a phenomenon which has not been reported before in pipelines, i.e. density currents, was detected. When a slurry contains significant amounts of fine particles of material which have very slow settling velocities, a density gradient will be created in the vertical direction. When a solids pipeline is shut down, the large particles in the slurry will quickly settle and form a bed on the bottom of the pipeline. The fine particles will establish a density gradient in the liquid above this bed, and the gradient sets up a circulating current in the sloped sections of any pipeline. The circulating current carries the very fine particles along the bottom of the pipe and down the slope. At the same time, relatively clear liquid flows along the top of the pipe, up the slope, to complete the cycle of flow. The result of a density current is that the fine solids are carried to the bottom of the slope where they will be deposited and could form plugs which would render the pipeline inoperable. The detection of these density currents in solid pipelines will provide an important understanding of the mechanisms involved inside pipelines that traverse undulating and mountainous terrain.

By the end of 1973 the solids pipeline group at Saskatoon had established itself as an outstanding center for research on hydraulic transport of solid materials. Experimental data from the various research programs of the division and information representing the published literature of the research, construction and the operation of solids pipelines over the past 80 years are now available through two information retrieval systems established by the division to assist in solving industrial problems and in examining the potential commercial schemes to utilize Saskatchewan's resources.

The implications of low cost transportation for materials that can be moved in large quantities are significant for Saskatchewan. As the following table shows,

Carrier	Cents per ton mile	Conditions
slurry pipeline	0.3 - 0.7	over 50 miles
rail	0.4 - 0.9	unit trains over 400 miles
conveyor belt	2.0 - 6.0	less than 15 miles
truck	5.0 - 8.0	one way haul, empty return

under certain conditions slurry pipelines can move some commodities more cheaply than railways. Almost as important, the existence of a competitive alternative to rail transportation will help to keep rail freight rates down.

The advantages of transporting certain solid materials by pipelines are many. Some are:

— high reliability; solids pipelines are shut down generally for less than two per cent of the time

— a pipeline has lower maintenance costs than rail, road or air transportation per ton of material transported

— there are no product losses, i.e. pilfering

— pipelines are less vulnerable than other forms of transportation to escalation of labour costs, because of low labour content

— pipelines can be constructed on steep grades relative to rail and truck routes and so can negotiate rough terrain better

— pipelines have an excellent safety record

— a pipeline is out of the way and below ground level; therefore is not affected by weather and does not contribute to pollution

Transportation is an activity that affects everyone in Saskatchewan. Historically, transportation issues always have been controversial issues because Saskatchewan's resources such as grain, wood pulp and such raw materials as oil, gas, potash, coal and metallic ores must be moved over long distances to world markets. The potential economic value of these resources to the province is largely dependent upon the cost of transportation of these commodities to world markets, while living standards in Saskatchewan are affected significantly by the cost of moving goods in and out of the province. Under present conditions and foreseeable markets in five years time, consideration can be given to transportation of materials surplus to Saskatchewan's industrial requirements such as potash to Vancouver for export overseas, potash to the Minneapolis and Chicago areas of the United States and lignite coal to southern Ontario for thermal power generation. In addition, consideration should be given to transportation of wood chips from forest to pulp mills in Saskatchewan, and metallic ores and concentrates to existing transportation systems within Saskatchewan.

Building Materials Made from Clays

The division maintains a ceramics laboratory to assist various companies engaged in manufacturing clay products in Saskatchewan. The objectives are to provide the laboratory facilities and technological expertise required by present manufacturers and to develop new products for the industry.

During the past year the laboratory worked mostly on contract research for various companies and for the Saskatchewan Department of Industry and Commerce. Staff managed to find some time to obtain field samples of clays and to explore the technology of producing potter's clay, floor cleaners and animal litter.

The ceramics laboratory has developed outstanding experience in Saskatchewan clays which is just beginning to pay off. The province has very large reserves of common clays and shales, fire clays, stoneware clays and ball clays. Kaolins and bentonites of various qualities also exist. Thus, Saskatchewan has the raw materials to make many types of structural products such as light weight aggregate, common brick, facing brick, fire brick, refractories, various types of tile, sewer pipe and flue liners. With superior technology, Saskatchewan producers should be able to increase their market areas with improved products and more economical production.

Protection of the Environment

Most communities in Saskatchewan encounter difficulties in obtaining a suitable water supply and, with the public awareness of environmental pollution increasing, must meet higher standards in sewage treatment. The division is studying ways to dispose of brines which will be produced by the spray freezing method of desalination of water supplies, the use of sewage effluent for irrigation purposes and the removal of nutrients such as nitrogen and phosphorus. The objective is to obtain sufficient information to determine the most desirable method of treatment for the unique conditions of individual communities.

The freeze desalination program has established experimental facilities to study brine disposal by discharge to sloughs, controlled dilution in a stream and solar evaporation. Only limited data are available to date. The use of fly ash to remove nutrients in sewage effluent is being studied under contract.

Under the sponsorship of the Saskatchewan Department of the Environment, the division prepared a plan for an experimental study to determine the applicability of waste water irrigation in Saskatchewan. As support material for the study plan, a literature survey was made and experts within the Council, from the Saskatchewan Department of the Environment, the University and from the Saskatchewan and Canadian Departments of Agriculture were consulted. The information obtained was summarized in the study plan which has been presented to the Department of the Environment. Since then, staff have continued to review the literature for new developments on waste water irrigation.

In Saskatchewan, as in other parts of the world, there is increasing awareness of the environmental damage which can be caused by discharge of municipal waste waters with a high nutrient content. Interest is being revived in disposal of these waste waters on land rather than to water courses. With land disposal, both the water and the nutrients can be put to beneficial use in production of forage or other useful crops. However, the

possibility exists for contamination of crops, soil or groundwater by salts, heavy metals or harmful organisms which may be present in the waste water. Consequently properly designed studies are required to ensure safe use of such waters.

The implications of the study are many. The entire water supply-sewage treatment and disposal system should be considered and a way found to minimize system costs and pollution effects for the rather different conditions existing on the Canadian prairies. The brackish groundwater supply for a community could be treated by the freeze process of desalination so that the community would receive potable water cheaply, and the salinity of the sewage lagoon effluent, which depends upon the salinity of the water used by the community, would be low enough to be used as irrigation water. At present, the lagoon effluents from most communities on the prairies cannot be used for irrigation because of the salinity of the water currently available to communities. The salinities of the various soils in the prairie region are usually high and this is a rather unique situation in North America. Obviously, a solution to the problem would be to co-ordinate the water supply of a community with the sewage treatment method so that the effluent water could be used for irrigation purposes.

Water Supplies

Annual precipitation in the southern third of Saskatchewan varies from 10 to 14 inches while evaporation can exceed 24 inches. Consequently development of surface water resources is important and the division has programs to provide basic data for the conservation and use of such water. The objectives are to provide measurements of the quantity of water available in small streams from spring runoff, to use the measurement data to develop methods of predicting the average amount of the water which will be available from each of thousands of small streams in Saskatchewan, to understand thoroughly the fluctuations in water levels in sloughs so as to determine the best uses of sloughs and to understand the water and salt balance of Big Quill Lake for possible recovery of the 20 million tons of sodium and magnesium sulphates in the water.

In an effort to understand the hydrology of small agricultural watersheds, the division began a small drainage basin study in 1961. The program now includes a total of six basins near Floral, Wilkie, Delisle and Wynyard. They range in size from about 150 acres to 20 square miles. The total runoff and the peak flows are measured each spring and the data are accumulated in a data bank. Using the data collected so far, staff have developed a semi-empirical model to predict the total flows and the peak flows to be expected from a given watershed. They have tested the model against the watersheds that have been under study for some time and the model has been found satisfactory. They are applying it to the drainage basins currently being measured by the federal government.

A member of the staff climaxed three years of development effort with successful field trials this spring of a fluorometric stream gauging method. In this method a

DYE TRACING TECHNIQUES for Saskatchewan's numerous small streams are employed to study spring snow melt. Larry Hesterman is shown setting up Council developed equipment at Wimmer Creek. The technique involves sampling a dye plume from a point on the creek at a known distance downstream.

fluorescent dye is added to a stream at a constant rate and becomes thoroughly mixed in the stream. The dye concentration in the stream will decrease as the stream flow increases and by measuring this concentration the stream flow rate can be determined accurately. The results of the field trials show that the division has developed equipment to measure the snowmelt runoff of ephemeral streams under extreme weather conditions which demand high reliability of operation. The equipment that has been developed opens an entire new range of fluorometric stream gauging applications and is attracting the interests of other groups. Because of the successful field trials in the spring, the division has selected a large number of small, representative drainage basins to cover various regions of the province ranging from the extreme southwest to the northeast.

The division has instrumented a number of sloughs and potholes in various parts of the province and has studied the amounts of water both entering and leaving these bodies of water and the meteorological conditions which prevail around these bodies of water throughout the summer. A fairly good understanding of the factors that affect the water levels, and hence permanency of the sloughs and potholes, is required to evaluate alternative uses of these bodies of water and to predict the hydrological results of agricultural practices such as brushing and draining of sloughs in certain regions. Staff have developed an accurate method of computing the rate of evaporation from sloughs and potholes and have successfully applied the method to reservoirs and lakes.

Big Quill Lake contains water that is too salty to be used for domestic or municipal purposes and is too dilute to permit commercial recovery of the 20 million tons of sodium and magnesium sulphates which are dissolved in the water. The division is making measurements of the water levels, the groundwater regimes, the spring runoff into the lake and the various meteorological factors in order to determine alternative ways of recovering these salts and using the lake for wildlife, recreation or water supplies. The work during the past year has concentrated on the development of a mathematical model of the lake

and on the determination of the physical characteristics of the lake and its surrounding and underlying regions. The mathematical modelling shows that the amount of groundwater which will enter the bottom of the lake is about 60 per cent of the precipitation which falls in the basin. Geophysical methods are being tried to locate any large areas of sand and gravel deposits through which the groundwater flows from the two aquifers under the lake. Staff are examining the use of both airborne and satellite remote sensing techniques to delineate specific areas of sand and gravel inexpensively.

The division's work on surface water supplies originated from requests from many agencies. The program is designed to provide basic data for many applications under Saskatchewan conditions. Availability of water in sufficient quantity, and of useable quality is an important factor in the growth and operation of farm enterprises. Farm communities depend considerably upon fresh water supplies from sloughs and dugouts which collect water from spring snowmelt runoff. The behaviour of small watersheds and land use practices control the quality and quantity of water available. Prediction of total flows and peak flows is important in the design and maintenance of bridges, culverts and stock watering reservoirs. An important consequence of the research program underway will be an ability to increase the yield of a small watershed by using snow fences or by modifying land use practices. The increasing number of feedlots in the province present a potential for land and water pollution because of dispersal of feedlot wastes through spring runoff. Proper design of such feedlots will require runoff information for small watersheds in areas where such data at present are non-existent.

Sloughs and potholes are part of the prairie environment and the hydrological significance of them has not been completely understood. The number in Saskatchewan varies from 600,000 to about 4.3 million depending upon whether there is a very dry year or a very wet year. They supply fresh water for a multitude of farm uses and when the sloughs are full they provide excellent sites for waterfowl production. Sloughs in groundwater recharge areas sustain the water table and regulate soil moisture. In recent years there has been a tendency in certain regions to drain sloughs and convert the land to agricultural production. Not enough is known yet to predict the long term effects of such a practice either in terms of wildlife production or flood potential in wet years.

The primary purpose of the Big Quill Lake study is the investigation of the hydrological balance of the lake in sufficient detail to permit economic decisions to be made for planning the future potential of the lake. Interest centers around the 20 million tons of sodium sulphate and magnesium sulphate in solution in the lake. However, the lake has social implications for recreation, wildlife and as a source of water supply. Once the sources of the water and the salts in the lake are known in some detail, it should be possible to exploit the system for the purposes of recreation or industrial production of the salts for the pulp and paper industry.

WATER BALANCE, the net water inflow or outflow, at Quill Lake is investigated with an elaborate network of instruments. This offshore platform carries air temperature, water temperature and wind recording instruments. If dried up, the bed of Quill Lake is a potential source of valuable salts, including magnesium sulphate and sodium sulphate.

MOST DUCKS on North American flyways make a stop in Saskatchewan during their annual migration. SRC studies on the hydrology of wetlands can assist in forming policies to conserve this valuable wildlife resource.

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E 73-18 Evaluation and Interpretation of ERTS Imagery for Big Quill Lake. Report No. 2. J. Whiting, November, 1973.

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REPORT OF THE GEOLOGY DIVISION

R. G. Arnold, Head

INTRODUCTION

The efficient use of our natural resources, without causing undue damage to our natural surroundings, is a current objective of society. This objective can be achieved by a proper understanding of our natural environment. Most people appreciate that the geological sciences have something to do with rocks and fossils but fail to comprehend the role that geology plays in the area of resource and environmental management. As in other physical sciences, geology can contribute to the solution of current problems principally by the collection of pertinent data and their intelligent interpretation and application. The geology division is currently involved in investigations in a number of areas involving the delineation and evaluation of large water-bearing aquifers and coal resources, in mapping glacial tills, sand and gravel sources in the southern inhabited region of the province, in groundwater level monitoring and the application of geochemical prospecting methods in Precambrian areas. The highlights of these programs are outlined briefly below.

GROUNDWATER GEOLOGY

The reconnaissance inventory of major aquifers in the inhabited region of the province is continuing under the supervision of E. A. Christiansen. The test drilling phase of the program was completed in 1970, but the mapping of near-surface glacial sediments was continued and will be completed during the 1974 field season. The information accumulated and compiled during the course of this program has proven invaluable in guiding the exploration for new water supplies, or augmenting existing supplies. The information provides guidance as to where or where not to drill, the maximum depth to which exploration should continue and, in many cases, the quality of water to expect in the various strata. Users of this information are farmers, towns and government agencies and they obtain this information both through direct contact with the division and through the Family Farm Improvement Branch of the Saskatchewan Department of Agriculture, who are co-operating with the division in disseminating the information to rural people. Publication of the results of this program are in the form of Groundwater Resources maps. Figure 1 is a summary of the maps published, those to be published during the 1973-74 program year and those remaining to be published in 1974-75.

Highlights of the work this year are the outlining of major aquifers in the vicinity of Fort Qu'Appelle, North Battleford and Swift Current. The Hatfield Aquifer underlies the Qu'Appelle Valley alluvium and can supply large quantities of water. Water-bearing sand, up to 80 feet thick, was discovered to underlie the North Saskatchewan River Valley between Battleford and North Battleford. The high available drawdown and permeability of these sands will assure an ample supply of groundwater to these communities. In the Swift Current area, 20 to 50 feet of water-bearing gravel and sand underlie the Swift Current preglacial valley which extends easterly from Swift Current to the vicinity of Rush Lake. This aquifer may become important as an additional water supply for

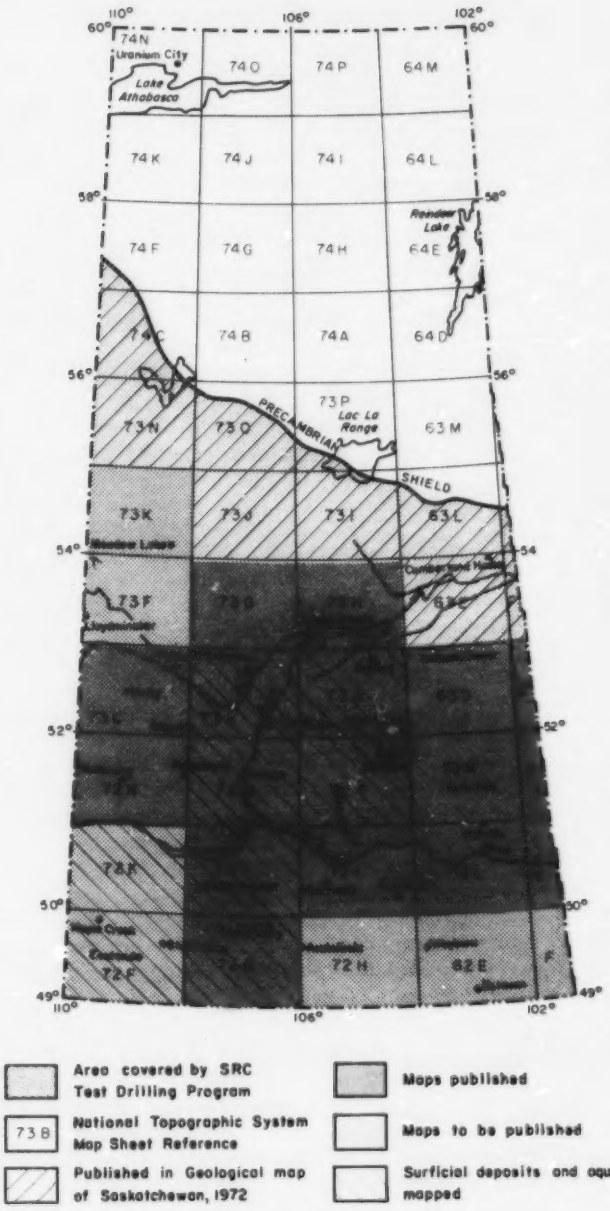


Fig. 1 - Map Showing Status of Groundwater Geology Project

Swift Current if the droughty trend in the southwest continues.

GROUNDWATER HYDROLOGY

Monitoring of groundwater levels in over 30 observation wells, throughout southern Saskatchewan, is continuing under the direction of W. A. Meneley. The results to date continue to indicate a strong correlation between the amount of precipitation and groundwater levels. The water level information derived from the network is providing information on the regional trends required for the evaluation of local water supply problems. The predictions made in 1971 and 1972, that water levels in shallow wells less than 100 feet deep in the southwest part of the province would continue to decline, is confirmed by the increased incidence of water supply problems in this region. A typical example is the depletion of the shallow aquifer at the village of Frontier. To alleviate the problem, a 1500 foot deep well was completed in the Judith River Formation which contains, in this locality, an adequate quantity of marginally acceptable drinking water. Unless precipitation increases in the southwest, many more water supply problems will occur.

Requests for information on groundwater sources from a variety of localities in the province increased markedly during the year which forced the postponement of a considerable portion of the normal scientific program. It is hoped that the complete publication of the series of Groundwater Resources maps scheduled for 1974 will help to reduce the number of requests.

The division was under contract with the Family Farm Improvement Branch to accredit electric-logging equipment used by water well drillers for the Department of Agriculture's test drilling assistance program. The accreditation program involved having each contractor drill and log a testhole. W. A. Meneley and E. A. Christiansen supervised the field program. The co-operation shown by the various contractors was excellent.

A second test of subsurface storage of water at Blucher was carried out. As in the first test, reported in last year's annual report, the water withdrawn from the aquifer was of considerably lower quality than that pumped into the aquifer. The success of this method of water storage appears to depend on the quantity of water-soluble material in the aquifer. Further experiments in artificial recharge are planned in depleted aquifers which had yielded fresh water.

LIGNITE COAL EVALUATION PROGRAM

Evaluation of Saskatchewan's lignite coal resources, initiated in 1971 was continued during the year and involved two separate projects. The major project is a three-year federal-provincial program, co-ordinated by S. H. Whitaker, involving joint field participation by the Department of Mineral Resources (P. L. Broughton), the Saskatchewan Research Council (S. H. Whitaker) and the Geological Survey of Canada (J. A. Irvine). The second project is the evaluation of coal permits held by the Saskatchewan Power Corporation.

The programs are designed to obtain a maximum amount of high quality information at low cost by using inexpensive, normal rotary-drilling techniques whenever possible. More expensive, reverse circulation rotary drilling or continuous coring methods are used only to meet specific sampling requirements. All testholes are logged by geophysical methods to provide a continuous objective measure of the physical properties of the strata penetrated in the holes. These logs greatly reduce the ambiguities normally associated with bedrock cutting descriptions and estimation of coal seam thickness and depth.

A brief description of the two coal evaluation projects is given below.

Joint Federal-Provincial Coal Evaluation

During 1973, field work was completed for the Joint Federal-Provincial Saskatchewan Coal Evaluation Program. Detailed drilling on roughly one mile spacings was carried out in areas in which promising coal occurrences were observed during the regional drilling program of 1972. Figure 2 shows the location of the areas of drilling concentration. In a few localities, detailed drilling indicated that no significant reserves were present; in these areas drilling was discontinued. Two drilling techniques were used during the program. Two normal rotary drilling rigs drilled 345 testholes for a total of 85,759 feet and a reverse circulation rotary drilling rig drilled 154 testholes for a total of 23,352 feet. The drilling pattern was designed so that reverse circulation testholes were distributed as evenly as possible throughout the areas in which lignite seams were best developed.

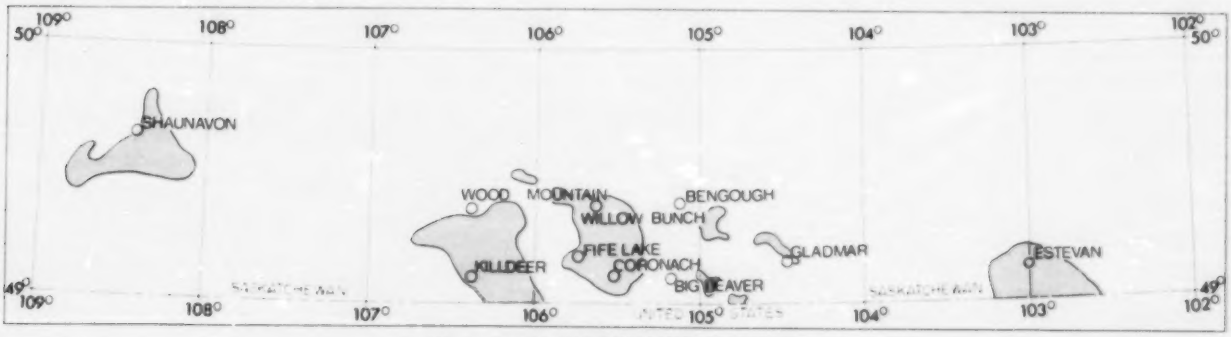


Fig. 2 - Areas of Detailed Drilling for Coal

Samples of the lignite were taken over one foot intervals through the seam where possible. These were collected from the testholes and shipped to the Fuels Research Centre of the Mines Branch, Canada Department of Energy, Mines and Resources, for chemical analysis. Samples from the reverse circulation testholes are considered to be the best samples obtained during the program and they will be used as the quality control network for evaluation of analytic results from the remainder of the testholes.

Geophysical logs were run in each testhole with a full suite being comprised of the following logs: spontaneous potential, single-point resistance, natural gamma, gamma-gamma density and caliper. In addition, a detailed log of natural gamma and gamma-gamma density was run over thick lignite seams where possible. Spontaneous potential and single-point resistance logs were not run in the reverse circulation rotary testholes.

Compilation of the drilling data during the coming year will provide the first realistic statement of lignite reserves for all the area outside the mine fields at Estevan.

Coal Permit Evaluation

The Saskatchewan Power Corporation holds coal exploration permits in all of the areas shown in Figure 2. Evaluation of all these permits was completed to approximately one mile centers in 1973 in all areas shown. In addition, evaluation of a portion of the permits within the Fife Lake - Coronach - Willow Bunch area was completed to one-half mile centers as part of a power plant feasibility study being conducted by the Saskatchewan Power Corporation. This program is under the direction of S. H. Whitaker and J. R. McLean.

Substantial reserves have been delineated in portions of several of the permit areas controlled by Saskatchewan Power Corporation, which will allow the Corporation to plan for future power requirements with several alternative sources of lignite available to it.

PRECAMBRIAN GEOLOGY AND GEOCHEMISTRY

Geochemical surveys initiated in 1973 in the Mudjatik (74-B) and Foster River (74-A) areas were continued during 1973 in the La Ronge area under the supervision of D. R. Haughton. A portion of the field work was conducted on behalf of the Department of Northern Saskatchewan who were carrying out a new mineral evaluation program in the area. The work for the department involved sampling bedrock, glacial overburden and lake sediments along lines cut primarily for geophysical surveys. To augment this coverage, the field crews carried out reconnaissance sampling adjacent to the areas of cut-lines.

All samples were shipped to the division for drying, screening, crushing and analyses. Copper, lead, zinc, nickel, manganese, iron, calcium, magnesium and molybdenum were measured by atomic absorption of hot 1:9 HCl/HNO_3 leach solution. Uranium was determined fluorometrically. Approximately 12,000 samples were collected and analyzed. The information will be of value for two main purposes: to establish the level of background concentrations of these elements in the various media and to detect unusually high concentrations of elements that might be indicative of economic mineralization.

To facilitate the standardization of geochemical field observations, a field card in computer format was designed (Figure 3) for use by all personnel collecting samples. At the termination of field work all field observations, geographic co-ordinate data for sample locations and element concentrations are merged on computer tape for statistical processing. A computer-controlled photoplotting procedure was devised by the University of Saskatchewan's Computer and Control Systems Research Laboratory to produce high quality geochemical data plots that require minimal drafting prior to publication.

Geochemical surveys hold considerable promise as a method for detecting the presence of mineral deposits in Saskatchewan — particularly in vast areas of glacial overburden which have generally been ignored in exploration programs and in government mapping programs. Ideally, such geochemical surveys should be combined with glacial geology studies to provide information about the source areas of the sediments.

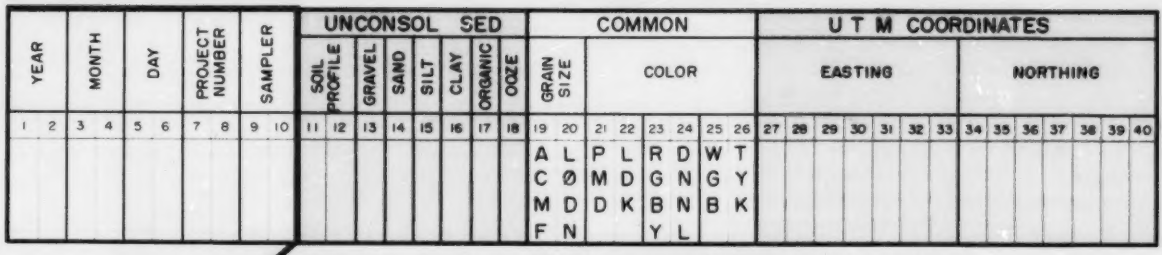
DRAFTING, CARTOGRAPHY AND AERIAL PHOTOGRAPHS

The cartographic staff are responsible for the design, production, and contractual supervision required for geology division publications. They also maintain complete files of available topographic and base maps, aerial photos and mosaics, E-logs and accumulated field data.

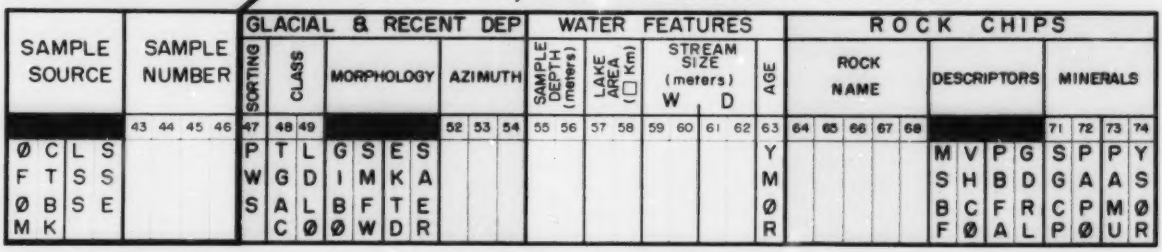
The program of constructing uncontrolled photomosaics of the province at 1:50,000 scale, compatible with the National Topographic System mapping, was continued. The current inventory is 479 sheets covering the province from 49° to 56° north latitude. Although the project was initiated to provide field reference materials for our geologists, the amount of interest shown by government agencies, educators and others has led to a wide circulation. There is little doubt that the mosaics represent a valuable tool for a broad scope of applications.

To complement the mosaic program, an index of all aerial photography done under federal contract, within the province, dating back to 1928 has been compiled. All pertinent information concerning aerial photography done in any portion of the province can be retrieved quickly. In addition; a complete series of 4 inches = 1 mile aerial-photographs, based on rural municipality coverage has been acquired from the Canada Department of Agriculture for historical reference purposes.

The cartographic staff completed five groundwater maps during the year, as well as two geochemical reports involving a large number of multicolor maps. Compilation on the 1:1,000,000 map of the province, the first of its type for Saskatchewan, has been completed to the topographic contour stage.



GEOLOGY DIVISION, SASKATCHEWAN RESEARCH COUNCIL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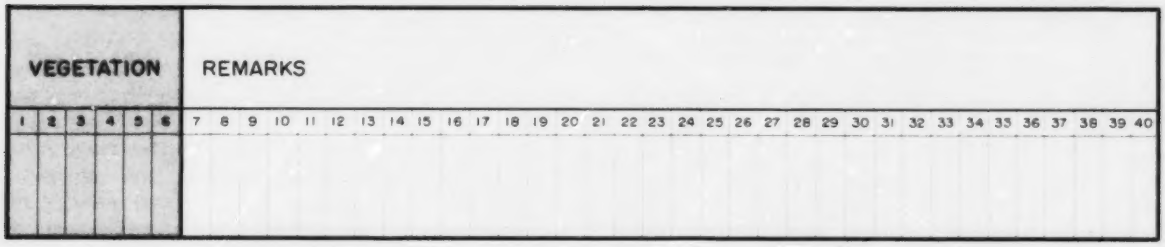


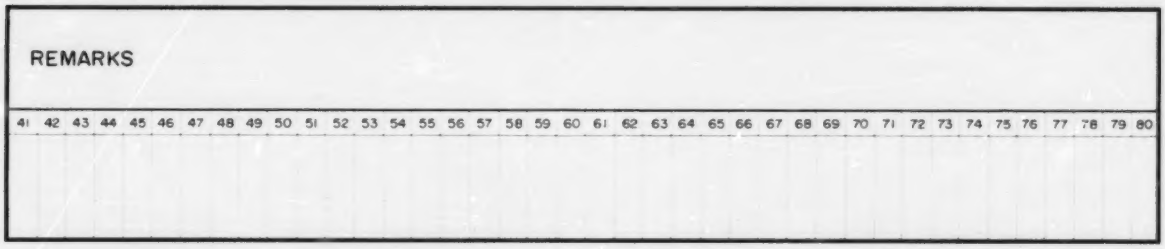


Fig. 3 - A Field Card, in Computer Format, Designed for Geochemical Surveys.

W. E. Taylor acted as co-ordinator with the Canadian Centre for Remote Sensing for all its airborne remote sensing for principle investigators in Saskatchewan during the 1973 season.

Reports and Publications

Arnold, R. G., Editor, Geology and Ore Deposits of the Hanson Lake-Flin Flon-Snow Lake Volcanic Belt of Saskatchewan and Manitoba, Geological Association of Canada Guidebook for Field Trip H, 1973.

Christiansen, E. A., Geology and Groundwater Resources of the Prince Albert area (73-H), Geology Division Map 15.

Christiansen, E. A., Geology and Groundwater Resources of the Shellbrook area (73-G), Geology Division Map 17.

Christiansen, E. A. and Whitaker, S. H., Geology and Groundwater Resources of the St. Walburg area (73-F), Geology Division Map 18.

Christiansen, E. A. and Whitaker, S. H., Geology and Groundwater Resources of the Waterhen River area (73-K), Geology Division Map 19.

Christiansen, E. A., Editor, Geology and Its Application to Engineering Practice in the Saskatoon-Regina-Watrous area, Saskatchewan, Geological Association of Canada Guidebook for Field Trip C, 1973.

Haughton, D. R., Arnold, R. G. and Smith, J. W. J., Geochemistry of Bedrock, Overburden and Lake Sediments in the Mudjatik area, Saskatchewan, Geology Division Report G 73-1, 1973.

Haughton, D. R., Concentration of Trace Elements in Overburden Associated with a Mineralized Boulder Train Near Fable Lake, Foster River area, Saskatchewan, Geology Division Report G 73-3, 1973.

Meneley, W. A. and Jaworski, E. J., Regional Observation Well Network Summary of Hydrographs 1964-1972, Geology Division Circular 6, 1973.

Whitaker, S. H. and David, P. P., Geology and Groundwater Resources of the Prelate area (72-K), Geology Division Map 16.

REPORT OF THE DIVISION OF INDUSTRIAL SERVICES

I. S. Evans, Head

INTRODUCTION

The division's broad objective is to increase the efficiency, effectiveness and so the profitability of industry operating within Saskatchewan. This objective is being achieved by:

- making scientific and technical information available to industry on a free and confidential basis;
- fostering the use of scientific and technical information by industry;
- providing technical assistance to industry;
- promoting the use of industrial engineering and management science by industry;
- making the services of industrial engineers available to industry;
- engaging in information science;
- adding to the Saskatchewan industrial infrastructure;
- undertaking specific studies under contract with provincial government departments.

In order to assist industry, the division provides the following services to industry. Through the Technical Information Service:

a) Technical inquiries;
b) Industrial engineering and management science;
c) Technological developments.

Through the Technical Assistance Program:

a) Aiding industry to obtain government financial assistance to conduct in-house research and development;
b) A science service library;
c) Specific services and studies undertaken on contract.

THE TECHNICAL INFORMATION SERVICE

The Technical Information Service is a joint National Research Council and Saskatchewan Research Council effort. The increasing financial and technical support of the National Research Council is most gratefully acknowledged.

Technical Inquiries

The technical inquiries section responds to specific requests from industry, especially small and medium sized companies, for information and advice. During the year, provincial industry's spectrum of interest has been as wide as ever and the following examples illustrate the variety and type of information and assistance supplied. One inquirier reports "the information received from you on air bubbler systems will be of considerable value in designing a suitable installation to protect the White Lake Dam from the effects of ice pressure."

Information on the performance, manufacturing methods, sources of supply, comparison of costs, lists of manufacturers in Germany and Italy of the required plant and machinery, sources of franchisable manufacture in Canada and pertinent standards of design have been provided to a local concrete products manufacturer that will enable him to add concrete poles to his list of products.

A provincial sodium sulphate company was using an inappropriate type of pallet to ship its product, resulting in lost orders and broken pallets. At their request, information on pallet design was forwarded. Using this information, the company redesigned its pallet and pallet handling techniques. The company estimates that the benefits accruing from this change are $70,000 each year. An additional benefit was that local lumber yards were given the pertinent pallet construction data and asked to bid on the company's requirements. The net result was $10,000 to $15,000 worth of additional business in Saskatchewan. In passing, it might be noted that the benefits from this inquiry, one of approximately 700, are more than equal to the division's cost to the province.

During the year *The Catalyst* has continued in monthly publication to remind provincial industry of the division's services and the continued, indeed imperative, importance of applying new knowledge to industrial problems and opportunities. The subjects discussed in *The Catalyst* during the past year were:

— Industrial Research Associations
— More On Innovation
— Technology Enhancement
— Technology Exchange
— The New Product I
— Recycling In Saskatchewan
— Philosophy For Entrepreneurs
— The New Product II
— Planned Innovation
— To See Ourselves

Industrial Engineering and Management Science

Within the scope of industrial engineering, which is defined as the design and installation of systems to achieve specific goals, it will be recognized that management and labor are parts of any industrial system.

An increasing emphasis is being placed on improving the use of human resources as a means of achieving

company growth and success. This is currently labelled Organization Development and can be broadly defined as an attempt to bring the goals of the organization and the people working in the organization into closer harmony.

Two approaches have been used to achieve this goal. The first is to define and then develop effective organizational structures, and the second is to increase the participation and involvement of the employees in the activities of the company.

In the first case several projects have been carried out to provide an improved organization structure, whereby the responsibilities have been more clearly defined and then delegated to the lowest appropriate level.

In the second case, a joint labor-management committee has been formed in a firm. Initially, the committee will evaluate positions in the firm and develop a sound wage structure. This will in turn form the basis for the consideration of various types of financial and non-financial incentives in the broad arena of motivation and worker satisfaction.

During the year particular attention has been paid to improvements in plant layout and materials flow. In one particular case a manufacturer's production was increased by 25 per cent with the same workforce through minor modifications in the materials flow. This project, as were many others, was carried out with the assistance of one of the company's employees.

The industrial engineering effort is becoming increasingly involved in financial analysis and long range planning for smaller companies. A number of companies have been helped in developing forecasts, preparing budgets, anticipating and satisfying manpower requirements and in developing presidential functions.

During 1973 the *Industrial Business Management* has been published monthly, discussing the appended subjects:

- Profile: The Plant Manager
- Checking Your Management Methods
- Avoiding Mistakes In Selecting Executives
- Keep Pointed Toward Profit
- Pareto's Law
- More Pareto's Law
- How To Use Pareto's Law
- Identifying Job Helps Effectiveness
- Fostering Industrial Development In Your Community
- How To Select Activities For Methods Improvement

Technological Developments

This service, operated by the National Research Council, brings to an industrialist's attention pertinent computer selected technical information matching his profile of interests. The division's part of this program is to make industry aware of the service and to help in preparing a profile of interests.

The importance of such information can be estimated from the following episode reported by one of the T.I.S. engineers. "During a routine scanning of the literature an article was found in a Japanese publication which appeared to be relevant to one of the Saskatchewan Power Corporation's operations. A copy of the article was sent to SPC with the result that it contacted the author (fortunately he was visiting Ontario) and arranged a whole day's meeting to discuss with him the implications of the information supplied."

TECHNICAL ASSISTANCE PROGRAM

Assistance in Obtaining Federal Research Support

It is held, with some considerable justification, that one of the principal means of expanding provincial industry's technological base is for industry to conduct its own research and development. Since these activities involve financial risk, the federal government shares the risk on approved projects employing approved people.

Of the many federal government schemes, those most applicable to the current Saskatchewan situation are:

the National Research Council's Industrial Research Assistance Program

the Department of Industry, Trade and Commerce's Program for the Advancement of Industrial Technology and Industrial Research and Development Incentives Act

the Department of Regional Economic Expansion (DREE) grants.

During 1973 and up to the time of writing, the division has assisted companies to obtain a total of $223,640 to support their own research and development. Six other applications are being processed — five for the Industrial Research Assistance Program (IRAP) and one for the Program for the Advancement of Industrial Technology (PAIT) for a total of approximately $720,000.

Computing a benefit to cost ratio for Saskatchewan on this activity shows that the ratio currently exceeds 10:1 and is estimated to exceed 25:1 by the year end.

Technical Service for Industry

For some time, thought has been given to helping industry to use the most appropriate technology to its needs. The success of such a program would require many specialists.

During the year, by way of example, tentative agreement was reached with the Canadian Welding Bureau and the National Research Council for the joint support of a welding specialist to work in and for provincial industry. The welding specialist will be required to:

- advise industry on welding methods and procedures;
- advise industry on the design of welded components and structures;
- help industry to choose the appropriate welding equipment;
- help to train operators;

— advise industry on post-welding operations, e.g. stress relieving and heat treatment;
— advise on special procedures, e.g. hard surfacing in ferrous and non-ferrous metals and alloys.

So far it has not been possible to obtain the services of a welding consultant.

INTER-INSTITUTE CO-OPERATION

One of the better ways of injecting more technology into provincial industry is to interest instructors and classes of the University and Technical Institutes in industry's problems. The students have the additional benefit of grappling with a real-life problem.

By way of example, a class of fourth-year agricultural engineering students became involved in the design of a ventilation system for an innovative method of raising poultry. The information so derived was used in the construction of the first research prototype building.

SCIENCE SERVICE LIBRARY

The library's principal function is to provide information support for the research program of the council and to provincial industry. As a working library, the emphasis is on service, by making pertinent material available. This is achieved by maintaining subscriptions to abstract journals and indexes; through inter-library loans and purchases. Virtually any non-classified document in the world can be obtained for the use of the Council's staff and provincial industry.

As in all libraries, available space rapidly becomes inadequate for the material collected. By discarding out-of-date material and acquiring new material on microfilm, it is hoped to maintain a steady growth of the library's material. Telex linkage provides very prompt results in obtaining material from libraries with more comprehensive collections.

It is hoped that sufficient space will be provided for a continued and more intense effort in collecting material pertaining specifically to Saskatchewan in the field of the physical sciences.

Most of the library's service to industry is provided via the Technical Information Service. However, the library's services are used directly by some industries through personal visits and by mail. Efforts continue to make provincial industry increasingly aware of the benefits to be gained by the systematic exploitation of scientific and technical libraries.

Specific Studies and Contracts

Towards the end of 1972 a submission was made to the Special Legislative Committee on Business recommending the establishment of a Saskatchewan Innovation Corporation. In the submission it was proposed that the Corporation would purchase pertinent technology, develop it to the prototype or pilot plant stage and then sell the enhanced technology to a Saskatchewan company for manufacture in the province and marketing in as great an area as possible.

The idea appears to have been accepted and, until the Corporation is in operation, the Saskatchewan Department of Industry and Commerce is funding the initial activities. This has taken the form of a contract between the Department and the division to select appropriate technologies for exploitation. To date, 23 cases have survived screening and two of these are being intensively investigated. At this early date it appears to be a fairly safe prediction that the effort will result in at least one factory per year being established in an industry, using a technology which is entirely new in the province.

Two other contracts are being undertaken. The first is the production of high protein animal feed from animal offal not now being utilized and the establishment of a tannery. Both these projects appear to be feasible but in a market where prices in the immediate past have been highly volatile. The second contract is for the production of fish meal from fish offal and unexploited fish species.

Some work has been undertaken for the Saskatchewan Department of Consumer Affairs in which the Mechanical Engineering Division of the National Research Council contributed generously with laboratory effort. The net result of this activity is the availability of very superior lubricants in the province.

OTHER ACTIVITIES

Members of the division continue to contribute to the deliberations of advisory bodies such as Industry Advisory Committees and the Mechanical Technology Advisory Board of Kelsey Institute, the Saskatchewan Metrication Committee and Advisory Committee to the Saskatchewan Automobile Experimentation Centre. In a similar way they have addressed service clubs and taken part in the annual deliberations of manufacturer's associations.

The division's efforts are a contribution to increasing the technical, managerial and entrepreneurial strengths of Saskatchewan industry with particular emphasis on achieving measurable results within the very short term.

RESEARCH
COUNCIL

REPORT OF THE PHYSICS DIVISION

J. Maybank, Head

INTRODUCTION

Research activities in the physics division are broadly related to the two areas of environmental quality and of resource development within the province. Projects primarily in the former area are designed to provide answers to problems concerned with the understanding and best use of the climatic environment and with reducing or ameliorating detrimental contamination and pollution effects. In the latter area the projects are intended to provide guidance on ways of managing resources and of optimising their use. Specific projects in these areas may be grouped for description under the headings of meteorology and geophysics. In addition to these research projects, the division maintains service laboratories for all Council staff for electronics and precision instrument construction and repair.

During the year, significant completed work included the following:

(1) The fabrication of 30 water level recorders of a design believed to be superior to any presently available instruments of this type. Steps are being taken to obtain a possible patent.

(2) The production of a mobile air sampling and meteorological observation facility. This will permit air pollution field trials and pollutant monitoring investigations to be undertaken anywhere in the province.

(3) The provision of a reporting format for farm well characteristics, that will enable such information to be stored, retrieved and analysed readily by computer.

A new development has been a contract with the Saskatchewan Department of Environment for the physics division to investigate the capabilities and applicability to the province of present remote sensing techniques. These techniques, using both satellites and aircraft, can, in principle, rapidly provide information on such matters as crop acreages, diseases, moisture conditions, forest operations and snow pack water content. Many other uses are considered possible.

METEOROLOGY

Studies relating to the atmospheric environment constitute a major portion of the physics division program. This work has led to benefits in the fields of hydrology, agriculture, construction technology and renewable resource management. Specific aspects of the research relate to pollution abatement, climatological analysis, weather probability estimates, irrigation system design and snow pack management.

Saskatchewan's Climate

In the past year considerable emphasis has been placed on computer analyses of climatic data. In this regard over 140 programs have been written and documented. A number of these programs provide for graphical data output as well as numerical tables.

The availability of the climate data bank and these computer programs has led to a gradually increasing number of requests to undertake specific contract work. Applications examined this past year include a preliminary study of icing events leading to power line failure undertaken for the Saskatchewan Power Corporation (report available), investigations of climatic data in relation to summerfallow practice on behalf of the Saskatchewan Fertilizer Advisory Council, co-operative studies with the University of Saskatchewan on the relationship between wheat yield and climate (with Dr. H. M. Austenson, Crop Science) and on forest fires and climate (with Dr. J. S. Rowe, Plant Ecology).

Considerable effort has been devoted to maintaining and improving the facilities at the Climatological Reference Station (CRS). Work, completed or planned, includes new mountings for anemometers and radiometers, installation of equipment to provide a vertical gradient of air temperature and a water system. Outdoor test bench facilities at the CRS site continued to be in demand, with the most extensive test involving the evaluation of a sonic anemometer.

Laboratory tests in the area of natural air drying of wheat at low temperatures was sponsored by the Saskatchewan Department of Agriculture, Family Farm Improvement Branch. Preliminary results in this area prove encouraging and extension of the work to other cereal grains is planned. A report has been produced.

A recently-acquired facility, microfilmed weather maps depicting surface and upper air conditions for North America, has added an ability to explore the dynamics of Saskatchewan climatic processes in general and of particular weather events occurring during the period covered by the archive.

Reduction of Pesticide Drift

The pesticide study is supported in part by an Extramural Research Grant from the Canada Department of Agriculture, and is designed to study the amounts of herbicides and insecticides escaping the area to be sprayed and drifting downwind either as droplets or as vapour. From these findings, recommendations are made to CDA of ways to reduce the hazards.

A series of field trials, eight by ground rig and two by aircraft, of 2,4-D amine spray was conducted this summer in co-operation with CDA Research Station at Regina. The sampling equipment was constructed through a grant from the National Research Council. The field sampling layout consists of 12 air sampling stations with total

capability for obtaining over 200 air samples during a trial, and is operated by a mobile power unit. A water soluble fluorescent dye was used in the study of droplet drift. A portable meteorological station, constructed in the physics division and instrument and electronic laboratories, was used to record the wind and temperature during the trial. The results are presently being analysed.

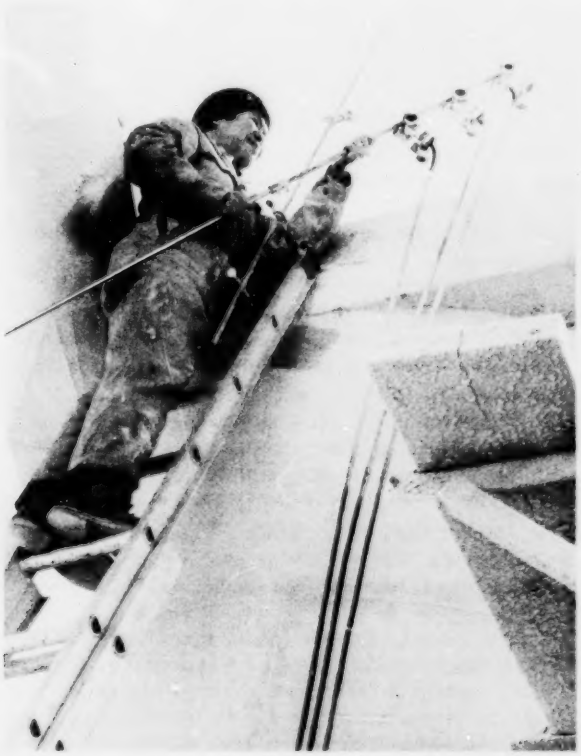
Preliminary findings indicate that approximately 3 per cent of the material emitted drifts beyond the swath boundaries. Higher volume spray rates appear to reduce this drift, as does the presence of a cowling about the spray boom.

By adding two new stations this year, the number of field stations for monitoring airborne 2,4-D during the spray season became eight in all, five being operated by SRC at North Battleford, Rosetown, Saskatoon, Naicam and Yorkton, and three by CDA at Indian Head, Regina and Swift Current. During June and July, a total of 50 samples were taken from each station and analysed by gas chromatography. Approximately 40 percent of the samples contained detectable levels of 2,4-D ester, with concentration ranging from 0.01 to 0.2 $\mu g/m^3$. Days with higher concentration were recorded in the middle of June and July at Rosetown and North Battleford.

PESTICIDE DRIFT in the atmosphere is monitored as part of a program to optimize spraying operations. This specialized equipment was fabricated in SRC's own shops.

Preliminary investigations on the drift of foam spray applied by aircraft were made with assistance provided by the Community Pasture Management Division of PFRA, Regina. The drifting of 2,4-D ester formulation with the foaming adjuvant was sampled at two sites of commercial application for brush control, one by a fixed-wing aircraft and another by a helicopter. The results obtained were compared with the result from conventional spray application. The foam spray showed considerable reduction of droplet drift, while the helicopter application resulted in a relatively high degree of droplet drift as compared to the fixed-wing aircraft.

A field test of drift control by aerial application of a new formulation of 2,4-D amine was conducted on a contract basis for a commercial firm. The samples taken are being analyzed.



AIR POLLUTION STUDY forms part of SRC's environmental monitoring program. Ken Yoshida is shown using cascade impactors to determine dust emission from pollution control equipment at a local feed mill.

Air Pollution Studies

During the year, dust emission conditions at a feed mill and a potash mine were investigated on a contract basis (see photo). Air samples were taken at the outlet of the surge tank at the mill, and the dust concentration at this point of emission into the surrounding air was determined. Particle size was also found and the results presented to the company.

From samples of airborne dust taken before and after the dust separation equipment on the potash drier

systems, discharge and control efficiencies were determined. The results were supplied to the client to help him improve the performance of the air pollution control equipment at the mine.

A contract with the Atmospheric Environment Service was recently signed, to investigate the amount, type and other characteristics of grain dust emission from a standard grain elevator during its various operations. The transition to larger elevators and centralized grain handling tends to expose residential areas of communities to higher contamination levels and the objective of this study is to determine what these levels might be immediately outside and downwind under different operations and weather conditions. Two communities close to Saskatoon have been chosen for the preliminary investigation, and dust sampling equipment is being set up at appropriate locations in these areas.

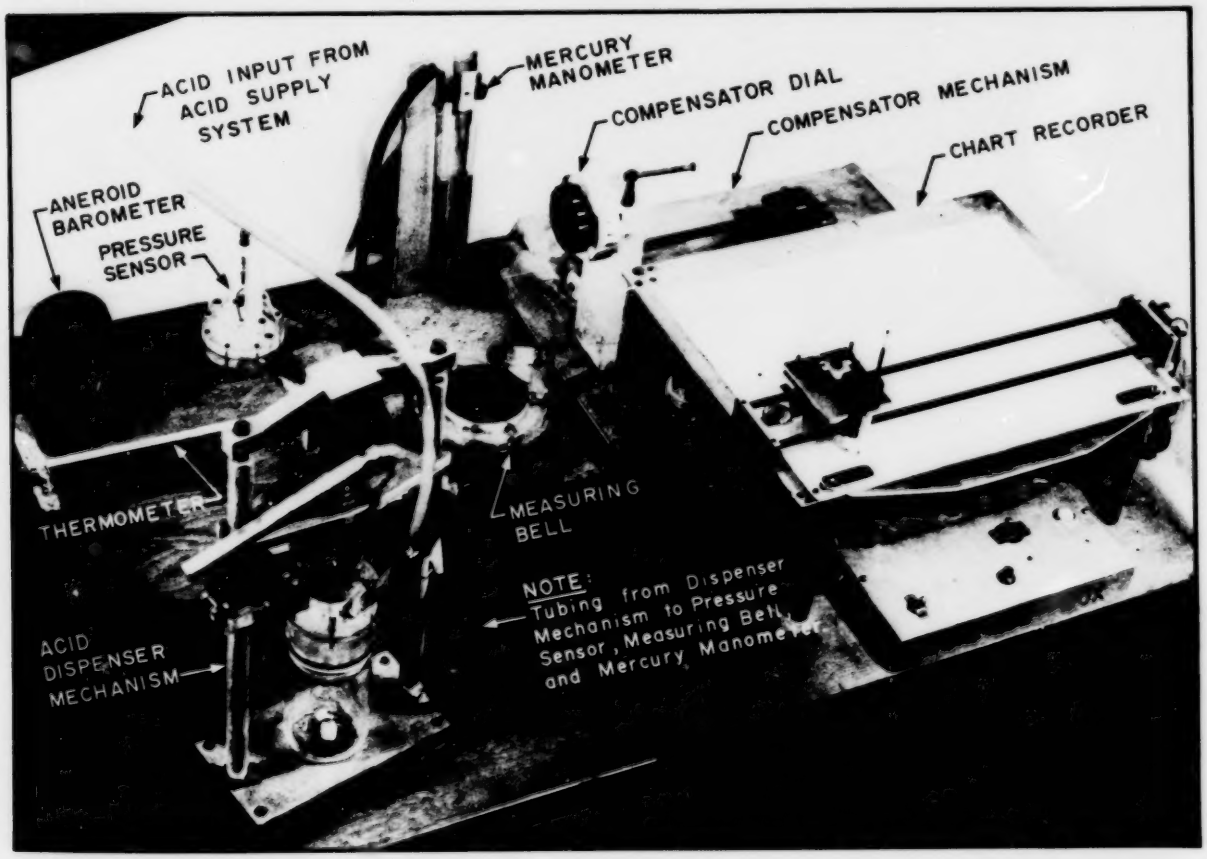
GEOPHYSICS

Research in solid earth geophysics involves studies carried out with other divisions of the Saskatchewan Research Council. The purpose is to provide information on Saskatchewan's groundwater and mineral resources and to provide a fuller understanding of their development potential.

Groundwater Availability and Quality

The continuing objective of this program, which has been supported by ARDA, is to engage in applied studies either to increase the chance of finding aquifers or to contribute to the technology of water well development. Projects in this area, additional to that of data handling studies, have involved work on farm well management and instrumentation graphics.

Most of Saskatchewan's farms, villages, small towns and even a few cities such as Regina and Yorkton rely on wells to supply much of their water needs. Knowing the well characteristics is a necessary prerequisite to their optimal usage. Measurements of water level and water consumption were recorded at two farm sites as part of a study on water production from shallow, large-diameter wells. The data were recorded and used to determine performance characteristics which in turn enable consumers and owners to use low-production wells more efficiently, thereby obtaining more water from them and increasing the life-time of the well. Both factors relate to the economic value of the well. The primary characteristic is the rate at which water enters the well to replenish the supply; this can be determined from water level measurements and is useful for solving farm water supply problems.



GAS VOLUME MEASUREMENTS from hundreds of samples of Saskatchewan glacial tills can be determined automatically by this apparatus developed by R. Heinze of SRC. When mixed with acid, glacial till samples evolve gaseous carbon dioxide in amounts characteristic of particular till sheets. This information provides insight into the province's geological history that is invaluable in assessing groundwater resources.

As part of the ARDA groundwater program, various instruments were designed and constructed for specific analytical and monitoring needs. The characteristics and potential of these instruments have been investigated for their more general capabilities and utilization.

Detailed technical drawings have been completed and are available for an instrument called the Heinze gasvolugraph (see photo). This device has been used extensively for the last three years by scientists in the geology division. Specifically, it provides a continuous record of gas volume produced during reactions to determine the carbonate content of core samples. The results are used to identify tills and intertill aquifers which were penetrated and sampled during the regional test drilling program. There are several distinct advantages of this instrument over alternative methods of measuring the volume of evolved gases. It is expected to have applications in a number of chemical analysis problems.

Detailed technical drawings for a second instrument (called the Multiple Program Sequenced Recording System, i.e., MPSRS) are nearing completion. This instrument is specifically used to record automatically the deep earth temperatures at the geology division's Duck Lake observatory. The purpose of this investigation is to determine the geothermal gradient and thereafter to check for the presence of thermal anomalies. These offer a means of detecting the flow of water through the soil, and it is expected that by accurately measuring small variations in temperature it will be possible to evaluate the rate at which water proceeds downward from the surface to replenish aquifers.

Lignite Coal Resources

The location, quantity and quality of the province's lignite coal resources is a vital inventory requirement for their optimal development and use. A co-operative program designed to provide this information is under way, involving the Canada Department of Energy, Mines and Resources, the Saskatchewan Department of Mineral Resources, and the Saskatchewan Research Council. While SRC's program is co-ordinated by the geology division, the main purpose of the physics division's work is to process the results of the chemical analysis of thousands of coal samples obtained in 1972 and 1973.

The analysis of the data is being undertaken in co-operation with Drs. D. S. Montgomery and T. E. Tibbets (EM&R). At this time all the analytical data available from the 1972 program have been key-punched onto computer cards. This card file represents information on nearly 1,500 samples from about 198 sites. Work has started on the 1973 data. A large effort is directed toward creating a *certified* data-base, that is, a collection of data which has been accurately and consistently edited and which resides on magnetic tape. This work is progressing on schedule.

Information and Computers

Much of the research in the area of geophysics has involved investigations of methods for computer handling, storage, retrieval and analysis of large bodies of data. These investigations have led to a computer use capability that is of much broader potential than just for groundwater or lignite coal problems.

Date processing projects have accounted for nearly a third of the effort in groundwater geophysics this year. Special emphasis was again directed at hydraulic-head and water quality information currently available in the geology division. Consideration of the output desired from the data is the most important step in data-processing. It must be done in co-operation with both the user and computer experts. After defining the objective, it is necessary to put the data into a computer-sensible format, then to edit that data to produce a *certified* file of information. Much work this year was directed at these two aspects of data processing.

Work, paid for by the Family Farm Improvement Branch (FFIB), was undertaken on behalf of the Test Drilling Assistance Program sponsored by the Saskatchewan Department of Agriculture. This program makes financial assistance available to bona fide farmers for the purpose of paying for part of the costs of drilling and electric-logging exploratory testholes in the search for groundwater. The design of certain specifications related to the operations of borehole logging and information handling was undertaken, and the necessary forms and computer system provided to FFIB.

A project was undertaken to index all literature holdings in the groundwater geophysics project area. A

COMPUTERIZED INFORMATION RETRIEVAL enables SRC scientists to quickly locate material concerning many aspects of a scientific problem. Here Mrs. Judy Grimsdale is shown coding an article concerning groundwater geophysics.

total of about 1,400 citations were coded and entered into a commercially available computer-assisted retrieval system called FAMULUS. The system has the capability of performing searches for citations. Search or retrieval is largely based upon words or phrases known as descriptors (see photo). Benefits of this work are that access to specific reference material will be easier and that comprehensive searches can be made rapidly and with little cost.

INSTRUMENTATION SERVICES

The electronics and precision instrument laboratories provide all Council divisions with facilities for designing, building and testing of electronic, electromechanical and precision mechanical devices. Maintenance and servicing of these and all purchased equipment is also provided when requested. In addition, the services of the two laboratories may, under contract arrangements, be made available for instrument construction and consulting for organizations outside the Council.

Electronics Laboratory

During the year the electronics laboratory continued to provide consultation, design, fabrication and maintenance relative to electronic instrumentation in support of the Council's research program. Major activities are described below.

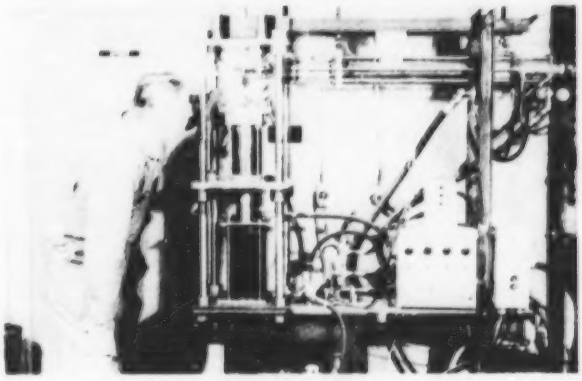
A data acquisition system, the construction of which was described in the previous year's annual report, has been installed at the Duck Lake hydrological observatory. Called a Multichannel Program - Sequenced Recording System (MPSRS), it is measuring and recording deep earth temperatures for the geophysical laboratory. The system has been upgraded by the additional installation of a standby AC power supply to prevent data loss due to commercial AC power failures.

The temperature sensing probes, used as transducers in the above system, have been so successful that numerous additional probes have been fabricated for both the engineering and geology divisions.

A solar radiation interface was designed and constructed for the engineering division. This interface allows both solar radiation and the temperature of the radiometer head to be recorded on a single channel analog recorder in a time shared mode. A counter and printer were also included to record the integrated solar radiation in digital form.

Two instruments, a phase marker and a preamplifier, were constructed under a contract with the Saskatchewan Department of Highways and Transportation. These instruments will be used in a measuring system for pavement evaluation.

During the year the laboratory acquired a precision digital multimeter to be used as a secondary reference standard for calibration purposes. In addition, a secondary frequency standard was designed and constructed by the laboratory. This will also be used for calibration purposes.



PLASTIC MOLDING is a new capability at SRC. Rudy Heinze is shown adjusting a Council-developed injection molding machine capable of making parts for scientific instruments. Data derived from operation of this machine is used to investigate the techniques and economics of short run plastic parts production.

Precision Instrument Laboratory

During the past year the activities of this laboratory can be roughly divided equally between development of new products and the repair and servicing of existing instruments. In addition, a small portion of time is allocated to improvement in laboratory facilities.

The injection molding press that was designed last year has proven to be an extremely versatile and valuable addition to instrument production. It is possible to use a wide range of different plastic materials, to combine several molds for multiple injection and to quickly change their combination as desired (see photo).

The injection molding press was used to complete the components for the water level recorders begun last year. A total of 30 of these instruments have been produced for geology and physics division groundwater programs. In addition, one actuator unit was constructed and sold to the Atmospheric Environment service, Canada Department of the Environment for evaluation purposes.

A total of 12 mobile air sampling posts was constructed for the pesticide drift trials described previously. They consisted of three tubes, serving as suction manifolds, to which samplers could be attached at six different heights. A remotely-controlled solenoid valve system was incorporated to allow sequential sampling to be carried out at each location. These sampling posts, and the meteorological observing post, were constructed as a joint venture by the instrument and electronics laboratory staff.

Reports and Publications

P 73-1 Electrical characteristics of severe hailstorms. J. E. Pakiam and J. Maybank, March, 1973.

P 73-2 SRCBAR: A computor program for plotting major ions found in groundwater. C. McKenzie, J. H. Dyck and W. A. Meneley, March, 1973.

P 73-3 Droplet and volatility drift hazards from pesticide application. Air Pollution Control Assoc. Conf., June 24-28, 1973, Chicago. R. Grover, J. Maybank, K. Yoshida, J. R. Plimmer.

P 73-4 Drift measurements of oil-in-water-in-oil bifluid spray. Presented at Canada Agric. Pesticide Society Conf., Victoria, Aug., 1973. K. Yoshida and J. Maybank, March, 1973.

P 73-5 Preliminary investigations of natural air drying of wheat at low temperatures. J. L. Bergsteinsson, March, 1973. (Confidential).

P 73-6 Heinze Gas-Volugraph. E. H. Perkins and J. H. Dyck, April, 1973.

P 73-7 Topoclimatic studies at Prince Albert, Saskatchewan. J. L. Bergsteinsson, May, 1973. (Confidential).

P 73-8 Analysis of dust emission from a feed mill. K. Yoshida, May, 1973. (Confidential).

P 73-9 The frequency of winter ice and wet-snow storm conditions at Saskatoon. J. L. Bergsteinsson and J. Maybank, May, 1973.

P 73-10 Determination of discharge rates and particle size distributions of dust from potash drier systems. K. Yoshida and J. Maybank, August, 1973. (Confidential).

P 73-11 Coal-Chemistry Transforms. J. H. Dyck, October, 1973. (Confidential).

P 73-12 Droplet Drift Potential of Herbicidal Spray from Ground Application. J. Maybank, K. Yoshida and R. Grover. Journal Publication.

P 73-13 Literature Indexing Using the Famulus System. C. A. Neudorf, October, 1973.

P 73-14 Drift Measurements of Aerially-applied 2,4-D Estemine Spray. K. Yoshida and J. Maybank, November, 1973. (Confidential).

THE UNIVERSITY PROGRAM

SCHOLARSHIPS

The Government of the Province of Saskatchewan offers graduate research scholarships tenable at either campus of the University of Saskatchewan. The purposes of the awards are to assist graduate students to prepare for careers in scientific and industrial research and to create interest in the development of resources and techniques that will advance the economy of the Province. The Council conducts the selection of the awards.

Awards valued at $3400 for the year beginning October 1, 1973 were made to:

(Mrs.) P. I. Tones — Biology, Saskatoon Campus
S. Helliwell — Chemistry, Regina Campus
(Mrs.) J. M. Johnson — Home Economics, Saskatoon Campus

GRANTS IN AID

Since its creation in 1947, Saskatchewan Research Council has provided grants to University of Saskatchewan applicants for applied research in the sciences. Twenty-five grants totalling approximately $95,000 were awarded in 1973. This includes $10,000 grants from each of the Saskatchewan Mining Association and the Saskatchewan Department of the Environment towards the study entitled *Evaluation of Soil Contamination and Crop Damage in the Vicinity of Potash Refineries* conducted by staff of the Department of Soil Science, Saskatoon Campus.

DEPARTMENT OF ANIMAL SCIENCE

1. Peas and Faba Beans in Milk Replacers for Calves

under the direction of
Professor J. M. Bell

Pea flour and pea protein concentrate are relatively inexpensive sources of protein for animal feeds and are produced within the province. Milk replacers fed to young calves contain high levels of protein which is usually of milk origin. Protein of pea origin would be a cheaper source of protein for the producer but previous work from this department has shown that the calf under two weeks of age has a poor ability to digest the protein and carbohydrate present in peas. Several studies are therefore being carried out with pea flour in order to improve its digestibility to the new born calf and to study its value in calves over two weeks of age.

In one study, pea flour was pre-treated with starch-thinning and proteolytic enzymes to break down both the flour and the protein components to easily-digestible fractions before being fed to calves. Milk replacers were produced on a commercial scale where 0, 25, 50 and 75 per cent of the protein originated from enzyme-treated pea flour. The digestibility of the energy in these rations was acceptable but the protein digestibility was low despite the multiple enzyme treatment. In another experiment, when pea protein concentrate, rather than pea flour, was treated with enzymes before being fed to calves the concentrate had a much higher protein digestibility. It was concluded that the presence of the pea starch reduced the effectiveness of the proteolytic enzymes. In a third experiment, dry enzymes were added to the milk replacer in order to enhance the enzymatic activity within the animal body. Used in this way, the enzymes were generally ineffective. The work on these projects was performed by Mr. Bruce E. Harvey, a graduate assistant in this department.

As it is known that calves over two weeks old are reasonably efficient at digesting pea protein, a fourth feeding trial is in progress where milk replacers containing 0, 25 and 50 per cent protein of pea-flour origin are being fed to older calves. In this experiment, the pea-flour is untreated and the feeding trial is being performed to study the growth rates of calves to determine the most effective way of measuring digestibility in milk-fed animals.

Laboratory work concerning the *in vitro* assay of milk replacers is continuing and results obtained from *in vitro* assays are being compared with *in vitro* results. Further laboratory studies will be concerned with the appearance and physical characteristics of milk replacers where a large proportion of the fat is provided by low-erucic rapeseed oil. Dr. G. I. Chrisison, a professional research associate, is carrying out these latter studies.

Publications resulting from earlier work in this project are:

Chow, C. and Bell, J. M., 1964. Effects of various heat and pH treatments on digestibility of protein in pea protein concentrate *(Pisum sativum)*. Can. J. Anim. Sci. In press.

Bell, J. M., Royan, G. F. and Youngs, C. G., 1974. Digestibility of pea protein concentrate and enzyme-treated pea flour in milk replacers for calves. Can. J. Anim. Sci. In press.

Bell, J. M. and Adams, Sandra C. M., 1974. The digestibility of rapeseed oil and of protein from a mixture of fish protein concentrate and brewers yeast in milk replacers for young dairy calves. Can. J. Anim. Sci. In press.

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING

1. Utilization of Fly Ash in the Treatment of Pulp and Paper Mill Effluents

under the direction of
Professor N. N. Bakhshi

Power plants in Saskatchewan produce large amounts of fly ash. Stockpiles of this material have been increasing over the years. Though a part of this material is being used in cement and other like applications, however, the problem of disposing of large amounts of fly ash still remains unsolved.

The purpose of this investigation was to use fly ash, a waste product of power industry, to treat the effluent from pulp mills. If this treatment is successful, it might open up a whole new avenue for a profitable disposal of fly ash.

Effluent was obtained from the bleach plant of the Prince Albert Pulp and Paper Mill and was found to have a Chemical Oxygen Demand (C.O.D.) value of 2660 mg/l. Measured amounts of fly ash were added to measured volumes of effluent, mixing the samples on a gyratory shaker at 200 rpm for 60 min. and then filtering them through a Whatman No. 40 filter paper. It was found that about 25 to 30 per cent of the initial C.O.D. was removed by fly ash dosage of 100 g/l. Work so far indicates that filtration step is very important for consistent results. Apparently, with Whatman No. 40 filter paper, some fine particles pass through the filter paper into the filtrate and make the results somewhat unreproducible.

At present, instrumentation is being set up to analyse C.O.D., color, suspended solids, turbidity and alkalinity. In order to obtain proper understanding of the process, it is planned to obtain adsorption isotherms for the fly ash-effluent system.

Mr. Randy Gillies, a graduate student, is working on this project.

2. Hydrogen Reduction of Sodium Sulphate

under the direction of
Professors W. J. DeCoursey and N. N. Bakhshi

Sodium sulphate is an important mineral in Saskatchewan. Most of it is used in making Kraft paper pulp. Reduction of the sulphate to the sulphide would reduce transportation charges, give a more valuable product for some applications in pulp mills and perhaps provide new markets. Previous work done in the laboratories of Saskatchewan Research Council gave promising results. The present project was concerned with improving the process to make it more attractive economically.

The earlier equipment was modified to recycle unreacted gas after removal of water vapor and to place a mechanical stirrer inside the fluidized bed to reduce agglomeration. No problems were encountered when the unreacted gas was recycled along with some fresh hydrogen. Results also indicated that it may be possible to reduce the amount of solids recycle required to prevent sticking and agglomeration of particles inside the reactor.

The experimental program indicates that the quality of fluidization (with hydrogen) is extremely important from the point of reproducibility as well as conversions. In some of the cases, where there was doubt about the quality of fluidization, the results were found to be erratic and the conversions were low.

Mr. George Bollman, a graduate engineer, assisted in the work on this project.

3. Chemical Analysis of Birch Bark *(Betula Papryifera)*

under the direction of
Professors J. M. Pepper and P. J. Smith

It has long been recognized that local birch bark is capable of resisting microbial decay for long periods of time. The project is concerned with the isolation and characterization of the chemicals in the bark which are believed to be responsible for the high degree of resistance to microbial attack. As well, this research program includes a testing of these chemicals for possible biological activity using several different fungi. Such compounds, if found to have antimicrobial action, may be useful for commercial utilization as a preventer of wood rot.

Birch bark, dried and ground, was extracted with cyclohexane. After concentration of the extracts, betulin crystallized out and, after separation and recrystallization, was obtained in pure form. It is of interest to note that betulin, approximately 35 per cent by weight of the dried bark, occurs by far greater amount in the bark of a birch tree than in any other type of tree bark. The cyclohexane extract, after removal of the betulin, was examined using column chromatography. The following compounds were obtained in pure form and identified using spectroscopic techniques and a comparison with authentic samples; lupeol, acetyl oleanolic acid and β-sitosterol. As well, a yellow oil was tentatively identified as a mixture of caryophyllene and ylangene. Further work is proceeding on the identification of other minor components.

Betulin is presently being screened against leukemia and rust infections on wheat. Betulin, allobetulin formate, betulin diacetate, acetyl oleanolic acid and a mixture of caryophyllene and ylangene were tested, using several different concentrations, against four different fungi. Although the results are inconclusive and further testing experiments are planned, it appears that betulin exhibits the greatest antimicrobial action.

Since betulin is obtained in good quantity and in pure form from the birch bark, it was decided to synthesize

several of its derivatives in the laboratory. Betulin monoacetate and diacetate, allobetulin formate and allobetulin were all successfully prepared. Betulin was oxidized with a mixture of CrO_3, pyridine and acetic acid to give several products which are currently being identified.

Mr. N. Johnson and Miss C. A. Boyle, summer research assistants, were associated with this project. It is planned to have a graduate student proceed with the investigation.

4. Flow Suspensions in Pipes

under the direction of
Professor C. A. Shook

An important constraint upon operating procedures for slurry pipelines is imposed by the necessity to avoid shutdown. If shutdown does prove to be required, it is essential to minimize this period because a *sliding* type of flow can occur. This flow can eventually produce blockage of a stagnant slurry pipeline. Experimental studies of the phenomenon and of related startup phenomena have been conducted in the laboratory. The *sliding* process has been investigated using gamma ray absorption techniques and has been shown to be a simple natural convective flow of the type which arises when two fluids of different density are present in the same pipe. In this respect the term *sliding* which is used in the literature is a misnomer.

Further studies are planned to allow theoretical prediction of the effect of pipe diameter and pipe length upon the problem. This research is co-ordinated with the work of the engineering division of the Saskatchewan Research Council staff. It is intended to explore the technical feasibility of alternative methods of transportation of bulk commodities.

Assistants on this project were J. Rollins and J. Liebe.

Publications

Shook, C. A., Rollins, J. R. and Vassie, G. S. Sliding in inclined slurry pipelines. Submitted to Can. J. Chem. Eng.

Shook, C. A. and Hubbart, L. T. Transient flow of a slurry. Can. J. Chem. Eng., *51*, October 1973.

5. Photochemical Degradation of Pesticides and Herbicides

under the direction of
Professor R. G. Sutherland

The Photochemical Degradation of Esters and Amine Salts of 2,4-D

2,4-Dichlorophenoxyacetic acid is the major herbicide used in this province. It is applied to the crop by spraying and it is important to obtain information on its rate of penetration into plants and its modes of decomposition both in the plant and its environment. Since most of the formulations presently used are volatile, work must be done on the interaction of radiant energy with the herbicide to obtain data on its stability in sunlight and to determine whether the degradation products present a threat to man and the biosphere.

Our previous studies have shown that aqueous formulations of amine salts of 2,4-D take at least two days for 80-90 per cent penetration. This means that the amount of herbicide on leaves, etc., which could be affected by sunlight, is large and so our first photolytic study involved the free acid, esters and amine salts in aqueous solution and in alcohol.

Free 2,4-D acid was quantatively converted to the corresponding esters when irradiated in alcohol solutions for 30 hours, 12 hours and 10 hours respectively, at wavelengths of 350, 300 and 250 nm. Dechlorination to o- and p-phenoxyacetic acid were produced in ca. 10-20 per cent yield. Photolysis of esters in hexane caused dechlorination at 300 and 250 nm but not at 350 and 420 nm. In general, as the chain length of the ester increased so did photolability. The n-butyl ester of 2,4-D is converted to n-butyl o- (and p-) chlorophenoxy acetate when irradiated in the vapor phase.

Photolysis of amine salts of 2,4-D in water produces dechlorination products; in methanol attack by solvent forms the methyl ether where dechlorination occurred. Phenylation occurs in benzene and amide formation was also observed. These processes involving solvent attack are possible in the environment since alkyl benzenes are used in amine salt formulations.

Since the final step in quantitating 2,4-D obtained from environmental sources is esterification, we have studied this process in some detail and have developed a reliable method for the quantitative esterification of 2,4-D. Methods have also been developed for the detection of 2,4-D in river water and some work has been done this summer on water samples obtained from the South Saskatchewan River.

Future work in this program will involve a study of the formulations used in the field when irradiated in thin films and a study of the photo-physical processes involved in the photolyses.

The graduate assistant involved in this program is Mr. S. S. Que Hee. Technical assistance was given by Ms. M. Vetter. The following summer students also assisted: Mr. D. Barton, Mr. K. L. Choi, Ms. J. Horner and Mr. B. R. Henshaw.

Publications

S. S. Que Hee and R. G. Sutherland, Penetration of amine salt formulations of 2,4-D into sunflower. Weed Science, *21*, 115-118, 1973.

S. S. Que Hee and R. G. Sutherland, The photochemistry and colatilization of 2,4-D esters. Abstracts Chem. Biochem. Herbicides, Regina, 1973, 13.

S. S. Que Hee and R. G. Sutherland, Pyrolysis of amine salts of 2,4-D. Abstracts Chem. Biochem. Herbicides, Regina, 1973, 16.

S. S. Que Hee and R. G. Sutherland, Pyrolysis of amine salts of 2,4-D. J. Agr. Food Chem. Accepted for publication.

Jesse Horner, Shane S. Que Hee and Ronald G. Sutherland, The esterification of 2,4-Dichlorophenoxyacetic acid. A quantitative comparison of esterification techniques. Anal. Chem., *45*, December, 1973.

R. Grover, J. Maybank, K. Yoshida, S. S. Que Hee and R. G. Sutherland, Monitoring of 2,4-D esters in the prairie air. Abstracts. Chem. Biochem. Herbicides, Regina, 1973, 10.

DEPARTMENT OF CIVIL ENGINEERING

1. Geotechnical Analysis of a Valley Crossing at the Arm River North of Findlater

under the direction of
Professor E. K. Sauer

The geology of the Arm River Crossing was studied in detail to develop investigation techniques for solving engineering problems with a highway crossing as a case study. It was found that a landslide, an unstable foundation under a large embankment with groundwater seepage problems and a bridge site location could be readily solved using this technque. The technique is not only extremely effective but relatively inexpensive. The procedure developed is being used by highway engineers and consulting engineers in the groundwater supply field and engineers involved with studying landslides. The project was in co-operaion with the geology division of the Saskatchewan Research Council and the Department of Civil Engineering at the Saskatoon Campus. It involved personnel of both agencies. The results of this study were presented at the Annual Geological Association of Canada Meeting, held in May, 1973.

2. Study of Foundation Conditions of the Downtown Area of Saskatoon

under the direction of
Professor W. G. Watt

In the City of Saskatoon, the boundaries of the South Saskatchewan River, 25th Street and Avenue B enclose an area of high density building development. Many multi-storied structures exist now and larger ones will be built in the future.

Heavy loads are transmitted by the foundations to the underlying soil. Foundation studies are restricted to small, built-up areas where access for drilling machines ordinarily used in soil explorations may not be available.

The objective of the research project is to prepare a report which would offer the geotechnical engineer designing a foundation, information on the soil formations, soil properties and the presence of water in the area surrounding a particular site. Knowing what to expect, he would immediately be on the alert if he discovered anomalous conditions in drilling on the site.

Prospective investors would have a general knowledge of foundation conditions from reading the report. It would also eliminate the need for deep exploratory holes at any particular site except for special settlement studies under very heavy buildings. Three deep holes into the bedrock and nine shallower holes into the glacial till overlying the bedrock comprise the basis for the geological report of the area. Samples taken from the shallow holes have been the basis of the engineering report on the soil properties.

Support was given by the geology division of the Saskatchewan Research Council in the drilling of the deep holes and in the geological interpretation of the data from them. The P.F.R.A. was helpful in supplying equipment to drill the shallow holes. Undergraduate students hired on the STEP and YES programs helped with initial surveys and laboratory testing. Mr. Walter Shtenko, graduate student, directed all phases of the work and is undertaking an analysis of the results.

The province as a whole will benefit if the analysis of the abundant data establishes differences of engineering significance between the two glacial tills underlying the downtown area because these same tills are the foundation of most heavy structures throughout the province.

It is proposed to publish the results in the summer of 1974.

DEPARTMENT OF DAIRY AND FOOD SCIENCE

1. Establishment of Quality Standards for Manufacturing Milk in Saskatchewan

under the direction of
Professor G. Blankenagel

Within the last year, Saskatchewan's dairy industry underwent significant changes. Approximately 80 producers of farm-separated cream converted, or are in the process of converting, to shipping industrial milk for manufacturing milk powder and cheddar cheese.

The purpose of this research project was to examine the present microbiological quality of such milk to compare methods, and determine criteria for its evaluation by government and industry. Since the completion of this work the *National Steering Committee on the Working Party on Milk Quality* has requested the results of this investigation to be used as guidelines for establishing uniform nation-wide standards.

Although microbiological standards for industrial milk are much more lenient than those for fluid milk, the quality of the former was found to be higher than expected. Median bacterial counts of 369 samples analyzed by an undergraduate student were:

Standard Plate Count (SPC)-32C - 2 days	=	70,000/ml
SPC - 25C - two days	=	70,000/ml
SPC - 25C - three days	=	100,000/ml
Psychrotroph count	=	30,000/ml
Thermoduric count	=	1,100/ml

It is anticipated that these counts will be still lower in the future as a result of improved milk handling facilities and continuous education of the industrial milk producer.

Since all milk is efficiently cooled in farm bulk tanks, the presence of bacteria able to grow at low temperatures (psychrotrophs) is of considerable interest. Unfortunately, the SPC at 32°C - two days does not include all of these organisms, and to complete a psychrotroph count requires 10 days. In search of a more rapid test to determine the psychrotroph content, several methods were tried and compared. It was found that the results obtained by incubating plates at 25°C for two days correlated best with psychrotroph counts ($r = 0.8654$).

DEPARTMENT OF ELECTRICAL ENGINEERING

1. Programming Additions to the Geographic Information System to Facilitate Its Use With Geophysical and Geological Data

under the direction of
Professor A. R. Boyle

A team of engineers and computer scientists has now been working for several years at the University of Saskatchewan to develop a system of automated cartography, and more recently has extended this to the development of an Interactive Environment Information System which is creating considerable interest.

The aim of the grant from the Saskatchewan Research Council is to extend some of the computational possibilities such as contouring and profiling as it is believed that this could aid the geological work at the Saskatchewan Research Council. Together with this there is appreciable interest in the general work on digitization and automated drafting of cartographic data, which is at present mainly supported by the Canadian Hydrographic Service and the U.S. Naval Oceanographic Office.

Many groups on the campus and in the province are also very interested in the extension of computational facilities. For example, the rapid preparation of area and perimeter values for lakes and rivers is of great interest to wildlife specialists. On a larger scale, the Churchill River Study is depending on us for assistance, and recently a large contract has been made between the Department of Northern Saskatchewan and the University (represented by this group) and the Institute for Northern Studies for the development of a full Geographic Information System to aid in their planning and decision making.

Other financial support in these areas is from the National Research Council and the Defence Research Board.

Since the start of the program of work for the Saskatchewan Research Council, a summer student, Mr. D. McEwan, had been employed to examine the best methods of interactive contouring when speed of response is of the utmost importance. He did not complete this work in the time available but is continuing part time. It is likely that extra effort will have to be given from other sources, particularly as he is also involved in the development of digitization methods and aspects of this of particular interest to the Saskatchewan Research Council.

No publications have so far resulted directly from this project but some papers of general interest are listed below.

The future of cartographic data in digitized form is good. The use of field surveys or photogrammetry, only to produce one drawn map, is no longer tenable. Data are required from which calculations may be made or appropriate symbolized maps made for communication of ideas or plans to the general public or political decision makers. These maps would have a limited selection of features of importance and be at the most appropriate scale and projection. The system being developed here enables such a map to be set up on the interactive display within a few minutes and, either a Xerox-type copy made in seconds, or the data output to a precision cartographic drafting system which can make final overlays ready for printing in a quality at least as high as anything that can be done by hand. The Saskatchewan Research Council, the Churchill River Study Group and the Department of Northern Saskatchewan appear to fully appreciate these facts. In the course of work with these various groups it is expected that most available topographic maps for Northern Saskatchewan will be digitized. It should be considered whether this should not also be extended to the south of the province.

The extension of the group's work to interactive display information systems is most interesting and we believe that we are a world leader in this area. Essentially, geographers have found that the presentation of location-specific data in map form has always been most helpful to lay-users; hence the atlas. The aim of our present work is to produce a dynamic atlas giving the most suitable presentation at any particular moment in time. No operator would be required and the user can communicate directly with his stored data enabling *mental modelling* to become more based on real information than at present.

Publications

A. R. Boyle, Automation in Hydrographic Charting. The Canadian Surveyor, Vol. 24, No. 5, Dec. 1970, pp. 519-537.

A. R. Boyle, Proc. of UNESCO/IGU Second Symposium on Geographica Systems (Ed. R. F. Tomlinson), Aug. 1972, Ottawa, Ch 6, 7, 15 and 16.

A. R. Boyle, A. Minicomputer Geographic Information System, Third Man-Computer Communications Seminar, NRC, Ottawa, May 1973.

2. Helium-4 Mass Spectrometry for Uranium Exploration

under the direction of
Professor G. R. Goldak

The purpose of this project is to design and construct a field-portable mass spectrometer system capable of detecting He-4 in ppm concentrations, and to employ this system to investigate the use of He-4 as a means of locating buried uranium deposits. The development of such a method would be of great significance in uranium exploration, not only in the Athabasca Sandstone region of Saskatchewan, but throughout the world. As a consequence, the project has attracted the interest of many

mining companies working in Canada, the United States, and Africa.

The pilot model spectrometer system was designed in 1969 and 1970 and built in 1971. During the summer of 1971, the instrument was taken to the base camp of Mokta Canada Ltée at Cluff Lake, Saskatchewan, and with their collaboration a two-week program of field testing was carried out. This work produced interesting but non-uniform results and as a consequence the instrument was modified in the winter of 1971-72. Further testing was done in the summer of 1972, and this produced results which were interesting and encouraging, but not completely definitive. Further instrumental modifications and laboratory testing were carried out during 1973, aimed mainly at increasing the reproducibility of the spectrometer. As a consequence of these revisions, both the complexity and capability of the system have been greatly improved. It now consists of an all-metal, completely bakeable system with LN_2-trapped polyphenyl-ether diffusion pumping, with an all-metal batch sampling system, and helium enrichment system. Due to shortage of funds, an extensive program of field testing was not possible in 1973. Several soil gas samples, however, were collected near the Gunnar mine, while the author was in Uranium City on another project. A helium contrast ratio of 12 was observed near the former open pit. Further field tests are planned. At the invitation of AIME, a paper on this work will be presented at their February, 1974 Conference in Dallas, Texas.

DEPARTMENT OF GEOLOGICAL SCIENCES

1. Stratigraphic Studies in Cretaceous Rocks

under the direction of
Professor W. G. E. Caldwell

Rocks of Cretaceous age underlie the surficial deposits and form the bedrock surface of a vast area of southern Saskatchewan. The younger rocks contain many water-bearing sands, as well as coal seams and pockets of natural gas; the older rocks contain reservoirs of heavy oil, formations of oil shale and deposits of industrial minerals. Stratigraphic studies are foundational to exploration programs that seek to identify the presence of these natural resources in economic quantities. The studies, described in this report, complement the investigations of the geology division of the Saskatchewan Research Council.

D. L. Barlow, an M.Sc. student whose work has been supported largely by the Council's grant, continued in 1973 a regional study of the geometry of sand bodies (some of these bodies known aquifers) in the Bearpaw Formation of southwestern Saskatchewan. Barlow is preparing thickness- and structure-maps which may enable him to relate the distribution of some of the sands to areas that subsided in pre-Bearpaw time following the solution of salt at depth.

Three other investigations have been supported to a limited extent by the Council's grant. M. G. Lomenda, also an M.Sc. student, has completed a petrographic and sedimentological study of the complex of sands in the upper Bearpaw Formation of the Cypress Hills. This work has made clear that the stratigraphy of the upper Bearpaw rocks has been grossly over-simplified. Rather than three sand tongues being present, as was believed hitherto, there are at least six tongues and lentils. Some consist of lenses stacked *en echelon* and probably represent ancient migrating off-shore bars and channel deposits. As many of the sands are aquifers, these discoveries have implications for water-well drilling in the area. Arrangements have been completed for the publication of Lomenda's work in 1974.

D. H. McNeil, a Ph.D. student, pursued in 1973 his planned revision of the Cretaceous section in the eastern plains, with emphasis on the Ashville Formation. He presented a paper on his interpretation of the Ashville rocks to the Annual Meeting of the Geological Association of Canada, in Saskatoon, in May, 1973. In an overlying formation, McNeil has been able to trace northward into Canada a number of thick seams of the industrial mineral bentonite, these seams first recognized at the base of the Pierre Formation in North Dakota. There are clear pointers to McNeil's work providing a much better understanding of the long-neglected Cretaceous sections in the Saskatchewan-Manitoba borderland.

Professional Research Associate, B. R. North and the grantee have completed a preliminary analysis of the Cretaceous foraminiferal faunas of the entire province. Sixteen zones have been recognized, and their relations have led to the recognition of three unconformities and to the substantiation of a fourth. These unconformities have a particular bearing on the interpretation of the White-Speckled Shale formations which, in the northeastern part of the province, are known oil shales. A summary of the foraminiferal faunas was presented to the Annual Meeting of the Geological Association of Canada, in Saskatoon, in May, 1973, and a further paper, describing the unconformities in sequence, was read to the Geological Society of America, in Dallas, in November, 1973. An illustrated handbook on the faunas is being prepared for publication by the Geological Survey of Canada. Systematic description of the components of the foraminiferal faunas is a continuing task.

Publications

Caldwell, W. G. E. and Lomenda, M. G., 1973, Progradational sands in the Late Cretaceous Bearpaw Formation of the Cypress Hills in Saskatchewan. Geol. Assoc. Canada, Abstracts for Annual Meeting, Saskatoon, 1973, p. 33.

Lomenda, M. G., 1973, Cretaceous Upper Bearpaw Formation in the Cypress Hills of Saskatchewan. Univ. Sask. (Saskatoon), M.Sc. thesis, 235 pp., 29 text-figs., 3 pls., 12 tbs.

North, B. R. and Caldwell, W. G. E., 1973a, Foraminiferal faunas in the Cretaceous System of Saskatchewan. Geol. Assoc. Canada, Abstracts for Annual Meeting, Saskatoon 1973, pp. 41-42.

North, B. R. and Caldwell, W. G. E., 1973b, Unconformities in the Upper Cretaceous Series of the Canadian Interior Plains. Geol. Soc. America, Abstracts for Annual Meeting, Dallas 1973, pp. 754-755.

2. Petrology and Stable Isotope Geochemistry of the Boundary Intrusions, Saskatchewan; Oxygen Isotope Study of the Flin Flon Cu-Zn District, Saskatchewan-Manitoba

under the direction of
Professor R. E. Forester

A diverse group of dyke-like intrusions, ranging in composition from felsic to ultramafic, crop out in the vicinity of Flin Flon. These rocks have been termed the Boundary Intrusions, and have been considered to be late- to post-tectonic in age. A graduate student, Mr. E. C. Syme, is studying the petrographic, chemical, and structural petrofabric characteristics of these rocks, with a view to better define the relationship, if any, between the Boundary Intrusions and other igneous rocks of the Flin Flon region.

A stable isotope laboratory is presently under construction in the Department of Geological Sciences. Equipment necessary to quantitatively extract both oxygen and carbon from silicates, oxides and carbonates is being assembled. A research program (on ore deposits in the Precambrian Shield) utilizing the

techniques of stable isotope geochemistry will begin after successful construction and testing of the high vacuum equipment.

3. Field Studies of Microseismic Energy Emission

under the direction of
Professor M. S. King

The occurrence of clay seams in the evaporite formation adjacent to the ore in several Saskatchewan potash mines often presents problems in strata control. These clay seams, in some cases, are responsible for local failure of the mine roof. A method for predicting such potentially dangerous roof falls is to monitor the microseismic energy released by the rock in areas where strata-control problems exist.

A laboratory study in the Department of Geological Sciences of the emission of microseismic energy by samples of potash has shown that a considerable amount of energy is released during the period immediately prior to failure. The object of the research supported under this project is to relate the results of the laboratory study to the prediction of roof failure underground. Results of the research program are expected to assist in determining the optimum safe system of mining potash in areas where roof falls are prevalent and possibly to predict the state of stress in mine pillars.

Two sets of equipment necessary to monitor the emission of microseismic energy underground have been designed and constructed at the University of Saskatchewan. After preliminary tests in a local potash mine had been successfully completed in 1972, the first set of equipment was employed in a second potash mine to monitor the stability of a mine opening. Results of these tests indicated that the number of microseismic events increased slightly when reloading of the opening due to adjacent mining occurred. However, twenty-four hours before the roof of the opening under observation failed there was a sharp increase (by a factor of 1000) in the number of microseismic events recorded. Microseismic events due to the mining machine and due to normal pillar unloading and reloading could be distinguished from those due to an impending roof fall.

The second set of microseismic equipment has been designed to operate in a small-diameter borehole deep within a mine pillar. It is intended to use this device this year to monitor the emission of microseismic energy as the borehole within the pillar closes by creep. There is reason to suspect that the build-up of stress within a pillar, as the surrounding area is mined, will be accompanied by an increase in microseismic energy emission.

A graduate student, Mr. A. Leuschen, is now completing an M.Sc. thesis based on the research described above. Considerable interest in safety aspects of this project have been shown by government agencies outside Saskatchewan and Canada.

4. Sedimentary Strata of the Prairies

under the direction of
Professor W. O. Kupsch

In the spring of 1973 the largest geological convention ever held in Saskatchewan saw more than 800 delegates gather on the Saskatoon Campus of the University of Saskatchewan. The topics discussed ranged widely, from the oil of the Canadian Arctic Islands to the coal of the southeastern part of our province. For this gathering of research scientists, a booklet was prepared on the history of geological exploration and the exploitation of mineral deposits in Saskatchewan(1). The contents of this booklet are based on research conducted by Professor Kupsch and funded by the Saskatchewan Research Council.

Through the many years that the *Sedimentary Strata of the Prairies* grant was available it has been used for several general compilations suitable for wide distributions, such as the *Annotated bibliography of Saskatchewan geology*(2). From a more narrowly defined grant dealing with specific aspects of the rocks underlying the southern half of the province, the money was shifted toward support of a variety of more general studies, some dealing with the North rather than the Prairies.

As grant support will terminate in 1974, now that Professor Kupsch has taken charge of the Churchill River Study outside the University of Saskatchewan, the above short overall accounting and evaluation seems appropriate. To these should be added the expression of gratitude from the recipient of the monies. The SRC grant has made it possible for Professor Kupsch to bring geological topics, coming from groups of specialists, to a wider audience, including the general public of the Province of Saskatchewan. For this he is most grateful.

Publications

Kupsch, W. O., 1973, Geological and mineral exploration in Saskatchewan — a precis of its history to 1970: Regina, Sask. Geol. Soc. Spec. Publ. No. 1, An excursion guide to the geology of Saskatchewan, Reprint, 34 p.

Kupsch, W. O., 1973, Annotated bibliography of Saskatchewan geology (1823-1970 incl.): Regina, Sask. Dept. Mineral Resources Rept. 9 (Revised Ed., 1973): 500 p. 2 maps.

5. The Proterozoic/Archean Contact in the Vicinity of the Hanson Lake Road, Saskatchewan

under the direction of
Professor M. R. Stauffer

Recent geological work and radiometric dating of rocks between Flin Flon, Manitoba, and Hanson Lake, Saskatchewan, indicates that the rocks near Flin Flon may be of Aphebian age (1800 m.y.), rather than Archean (2400 m.y.) as previously thought, and that there may be an important structural contact between Archean and Aphebian rocks between Flin Flon and Hanson Lake. Since many of the ore deposits that occur within the

Canadian Shield are located along or near contacts between rocks of vastly different ages, it is of considerable possible economic (as well as scientific) importance that this contact be investigated, first to determine its existence, and secondly to delineate its location.

The present project involves Rb/Sr, Pb/Pb and K/Ar dating of intrusive and volcanic rocks south and west of Flin Flon, in order to determine their age(s) and thermal histories. To date, one paper has been published, based on the preliminary data collected from this and other studies in the area (reference below). As a preliminary to dating of the Amisk Group and associated intrusive rocks, a detailed mapping project has been undertaken by Mr. Rod MacQuarrie to determine the relative ages of the intrusive rocks and further to determine the ages of these rocks relative to orogeny and to deposition of the Missi Group (which overlies the Amisk Group). Mr. MacQuarrie is working on an M.Sc. project and should be able to present results by Spring 1974.

Publication

Mukherjee, A., Stauffer, M. R., and Baadsgaard, H., 1971. The Hudsonian Orogeny near Flin Flon, Manitoba: a Tentative Interpretation of Rb/Sr and K/Ar ages. Can. Jour. Earth Sci., v. 8, p. 939-946.

COLLEGE OF HOME ECONOMICS

1. Pollution of Soil, Water and Food by Pesticide Residues in Saskatchewan

under the direction of
Professor A. K. Sumner

Trials were carried out to determine the most suitable crops to grow on soil contaminated with chlordane or Dyfonate. Pesticide research included evaluation of the pollution potential of two relatively new pesticides; Phosvel and Vitavax. Work was discontinued on the development of a commercial process for removing mercury from processed fish. A new project was undertaken to evaluate the contamination potential of treated sewage sludge when used as a fertilizer for horticultural crops. These studies were carried out in collaboration with Dr. J. G. Saha, Canada Agricultural Research Station, Saskatoon. University and other personnel associated with these research projects were Dr. Maitreyi Saha, Mrs. Diane Simpson, Miss Linda Gracey, Mr. Lorne Harman and Mr. Wayne Craig.

Chlordane and Dyfonate Residue Contamination of Soil

Trials were carried out at Outlook, Saskatchewan to determine the most suitable crops to grow if vegetable farm soils get contaminated with chlordane or Dyfonate. Treated soil containing about five ppm (dry basis) of technical or AG chlordane, an organochlorine pesticide, was used to grow a variety of crops. Maximum concentrations of chlordane residues found in the crops on an *as is* basis were: carrots 2.26 ppm, potatoes 0.12 ppm, field peas 0.02 ppm, alfalfa 0.03 ppm, mature wheat 0.01 ppm. Similarly, treated soil containing about 1.5 ppm (dry basis) Dyfonate, an organophosphorous pesticide, was also used. The crops were found to have maximum concentrations on an *as is* basis as follows: carrots 4.00 ppm, potatoes < 0.01 ppm, fresh peas 0.04 ppm, field peas, nil, alfalfa < 0.01 ppm, wheat grain, nil.

These results demonstrated that root crops such as carrots and probably potatoes should not be grown on such contaminated soils but crops such as peas, alfalfa and wheat are much more likely to meet safety tolerances.

Pollution Potential of Phosvel

A study was undertaken on the environmental pollution of Phosvel, a low-persistent phosphonate insecticide with quite wide potential applications in Saskatchewan. It was planned to analyze residue levels of Phosvel and its metabolites in cereal and oil seed crops grown in treated soil. Unfortunately, the reported analytical methods did not give satisfactory results with these types of crops due in part to chlorophyl interference. Extensive research to modify the analytical procedures was unsuccessful so the project was discontinued. The project was financed jointly by Velsicol Corporation and Saskatchewan Research Council funds.

Pollution Potential of Vitavax

Vitavax has replaced organomercurial seed dressings. It was considered prudent to study the effect of Vitavax on seed eating birds especially with regard to the accumulation of residues in birds such as pheasant, hatchability of eggs and survival of the young. Pheasants were fed Vitavax treated seed as well as 40 mgm Vitavax ^{14}C in capsules and the results were compared with controls. It was found that Vitavax was rapidly eliminated from the bird's body and only a low level (maximum two ppm) was excreted in the eggs for four to five days after treatment and then decreased to a non-detectible level in three to four days. There was no apparent effect on the number of eggs which hatched, or on the survival of the young.

Mercury Removal from Processed Fish

A project carried out under this grant during the past several years has shown that it is possible to reduce the mercury content of processed fish muscle tissue. The most effective method involved a modification of the commercial isopropanol extraction process for making fish protein concentrate. The modification consisted of treating the ground fish tissue with hydrochloric acid before carrying out the solvent extraction. Results showed that about 90 per cent of the mercury could be removed by this process. The preliminary work is described in our report:

Simpson, D., 1971. The effect of processing techniques on mercury removal from fish muscle tissue, Saskatoon, Saskatchewan.

While repeating this work prior to publication almost identical research was published by

Regier, L. W., 1972. Mercury removal from fish protein concentrate. J. Fish. Res. Bd. Canada *29*, 1977.

This project has now been terminated.

Treated Sewage Sludge as a Fertilizer

Increasing requirements for sewage treatment has resulted in disposal problems for the resulting treated sludge. One potential outlet for the sludge is as a fertilizer for horticultural crops. There is concern, however, that the metals in the sludge might contaminate the crops. Trials were undertaken to grow carrots and lettuce in soil treated with two levels of sludge. The soil and crop samples are being analyzed for lead, zinc, mercury, cadmium and selenium with assistance from the Saskatchewan Department of Public Health.

Publications

Saha, M., A. K. Sumner and J. G. Saha, 1973. Comparison of three extraction and clean-up methods for determining carbon-14 labelled residues from wheat plants grown in soil treated with Dyfonate-ring-^{14}C. J.A.O.A.C.

Sumner, A. K., M. Saha and J. G. Saha, 1972. Extraction of residues of Dyfonate-ring-^{14}C., Soil. Interm. J. Environ. Anal. Chem. *2*, 139.

DEPARTMENT OF HORTICULTURE SCIENCE

1. Fertility and Cultural Studies with Irrigated Vegetable Crops

under the direction of
Professor D. H. Dabbs

The objectives of this continuing study have been stated in previous annual reports. In general, the purpose is to develop more precise guidelines for growers of irrigated vegetable crops in Saskatchewan. The strictly production-oriented fertility aspect of the earlier studies has been terminated. Research emphasis in the last two years has been directed at the potential boron problem with rutabagas on some of the lighter textured irrigated soils in the Outlook area, as well as at the hollow heart problem in Netted Gem potatoes. In 1973 the entire field and greenhouse effort was directed toward the potato problem.

In irrigated field trials at Outlook, nine combinations of differing nitrogen, phosphorus and potassium levels were tested on four different clonal selections of Netted Gem potatoes. This experiment was designed to especially study the possible positive effects on potato hollow heart due to *luxury levels* of K_2O. Such positive results have been obtained in some other areas. A concurrent greenhouse trial was conducted on one clonal selection only. At this date, the only data available are those for tuber yields and, as was expected, added potassium levels have had no effect. The hollow heart situation will be assessed shortly.

Greenhouse trials with Netted Gem potatoes were also conducted during the summer of 1973 to test the effects on incidence of hollow heart due to differing soil temperatures, differing levels of soil boron and moisture stress applied at specific growth stages of the crop. Results of these trials are presently being compiled and will be assessed shortly.

All of the research with boron has been conducted in close co-operation with Dr. J. W. B. Stewart of the Saskatchewan Institute of Pedology, Saskatoon, and part of it with Mr. R. W. O'Donnell of the Saskatchewan Research Council. This, and other work in Dr. Stewart's laboratory, has demonstrated that boron levels in the lighter textured soils in the Outlook area are borderline for such boron-sensitive crops as rutabagas and difficulties may be expected in certain seasons. A method for boron determination in soil, plant material and irrigation water has been automated by the soil fertility research laboratory and it is expected that a boron determination will soon be included automatically in all soil tests on light-textured and irrigated soil. The present limitations are in establishing crop requirements for Saskatchewan soils and growing conditions, particularly for crops other than rutabagas. The present potato studies should help to clarify the situation with this crop.

Publication

Gupta, S. H., 1970. Extraction and determination of soil boron. M.Sc. thesis, Dept. Soil Sco., Univ. Sask., 114 pp.

2. Remote Sensing of Moisture Stress, Weed Competition and Salt Accumulation

under the direction of
Professor S. H. Nelson

The work on this grant was initiated in 1972 on commercial potato fields in the South Saskatchewan Irrigation Project and on small plots on light sandy loam and heavy clay loam in Saskatoon. The work continued in 1973 at both locations, but on a reduced scale in the irrigation area because there were fewer potato growers in the area.

As in 1972, the low level flights to be made by the Canada Centre for Remote Sensing were not carried out. Thus, the normal package of black and white infra-red with various filters was not available and only the colour infra-red 70 mm transparencies from photographic runs in a rented Piper Twin Apache aircraft were available. These were taken by Mr. G. Gentle of the Canadian Wildlife Service using their equipment. The plot areas at Saskatoon were photographed by Audio-Visual Services from a *giraffe* truck supplied by the Parks Department, City of Saskatoon.

Over the two years there has been a large amount of imagery to review and this will continue during the winter until a critical evaluation can be made in a full report. It is not planned, however, to request further funds for this project. The practicality of the exercise is being questioned on a number of points.

1. The turn-around time between flight, to receipt of proofs, to ultimate receipt of prints, is far too long to allow any corrective action to be taken on moisture stress which was one portion of this study.

2. The medium level flights (17,000 ft. AMSL) are too high for diagnostic surveys on row crops and the low level flights at between 2000 and 3000 feet are questionable because of the large amount of imagery and the personnel required to scan it.

3. Admittedly stress signatures can be observed particularly with infra-red film, but the signatures of stress caused by lack of moisture, too much moisture, salt accumulation, disease and mechanical damage are apparently indistinguishable from aerial photography. Although the literature reports illustrate remote sensing uses for this purpose, the preliminary research was done on known pure treatments and was not attempting to

assess individual plants scattered in a large dense population.

4. Although our early survey would suggest particular signatures from certain weeds in the plantations, these observations were made on relatively pure mono populations and further work where a wider range of weeds was present clearly demonstrated that distinguishable signatures for most weeds scattered through the population were not available from the film-filter combinations used in these studies.

5. The stage of growth of the cultivated crop, its varieties and the competing weeds has a vast effect on signatures which makes interpretations difficult.

On the positive side of the study, however, the aerial photography, and particularly infra-red photography, does show very clearly the decreased vigor and stressed nature of plants in low-lying areas. This is not nearly as apparent from the ground. This is of vital concern to the irrigated areas of Saskatchewan and certainly in the South Saskatchewan Irrigation Project these low yielding or unusable areas are seemingly increasing in size where high moisture levels are being applied to row crops in the rotation.

DIVISION OF NATURAL SCIENCES AND MATHEMATICS — Regina Campus

1. An Evaluation of the Origins of Iron Bacterial Found in Saskatchewan Soils and Water

under the direction of
Professor D. R. Cullimore

The objective of the study has been to develop methods for culturing and enumerating iron bacteria in groundwater supplies and soil. Suitable culturing techniques have been developed for studying the iron bacteria both in the laboratory and also in a submerged culture vessel at different depths down wells. Remote monitoring systems are being developed to allow studies at unserviced sites. A broad survey of the numbers of iron bacteria in well-water samples is being undertaken.

2. Thermal Properties of Salts

under the direction of
Professor K. E. Johnson

Preliminary experiments were done to study the zone melting of a KCl sample containing 0.1% Ba(11). Difficulties were encountered during preparation of fused DCl-$BaCl_2$ due to leaking in the Pt boat used to hold samples and possibly to incomplete drying of salts. Original zone melting experiments were unsuccessful due to *running* of molten KCl down the sample boat. Angle of elevation was powered from 4° to 2° and experiments repeated. After completion of an experiment, the ingot was divided into two cm segments and analysed by A.A. for Ba(11) content. Effective distribution coefficients, K, could be determined from

$$\log(1-c/co) = \log(1-K) - \frac{Kx}{1}$$

using a least squares fit program. Results obtained from calculating K from the slope and intercept are shown in the attached table. Insufficient data on dependence of K on speed of zone travel prevents calculation of diffusion coefficient, D, and equilibrium value of K, K_0.

Speed	Ba(11) in KCl K (slope)	K (intercept)
15 cm/hr zone - 6.7 cm	0.2366	-0.0990
12 cm/hr zone - 3.6 cm	0.0838	0.1005
15 cm/hr zone - 3.5 cm	0.1434	0.0971

This study is being resumed under a different grant and work of more immediate potential to provincial needs — thermal properties of substances available for energy conversion systems — is being initiated.

3. Preliminary Study of Alkali and Alkali Earth Metals in Saskatchewan Evaporites

under the direction of
Professor G. R. Parslow

The objective of the study is to obtain more information on the distribution of the following elements in the Prairie Evaporite: Na, K, Li, Rb, Cs, Ca, Sr, Ba. Later work will add the elements Mg, I, Br, B to the list.

Having obtained the distribution factors relevant to these elements, the project will be concerned with (a) outlining areas of economic potential for rarer elements such as Rb and Cs (if any), (b) use the trace element distributions to characterise the Prairie Evaporite stratigraphy and (c) to use the data to suggest possible origins of and subsequent diagenetic changes in the evaporite sequence.

Since only two-thirds of the support requested was received, the original plan of travelling to Lanigan a number of times to sample the ore zone was abandoned. Instead, a recently completed core of the Prairie Evaporite sequence in Regina was selected for detailed study (HIDROGAS REGINA B7-29-17-20-W2). The main point to note is that the Regina section contains no Carnallite and thus the first part of the study will deal with Halite and Sylvite only. It is hoped that the later work will cover the Carnallite rich part of the sequence.

The core was slabbed, according to Saskatchewan Department of Mineral Resources size restrictions, using a radial arm saw fitted with an abrasive blade of silicon carbide. Cutting averaged 50 ft. of core per day. Dust was a problem, but this was overcome by working outside.

A rough petrographic study was undertaken on the cut material; however, the distinction between Halite and Sylvite in this particular core proved very difficult. The core was then split into four inch units and crushed to produce some 1000 sample powders. Some crushing remains to be completed. Each sample will be analysed for the elements mentioned above to obtain a detailed knowledge of their distribution and variation throughout the sequence.

Mineral separation has proven a problem. Tetrabromoethane is being used as the heavy liquid and acetone the dilutent and wash liquid. However, it was found that a pure separation of Halite from Sylvite took some three hours; this multiplied by at least 1000 samples indicated that the method was too slow! In the course of this separation it was found that partial mineral separations could be completed in less than one hour; after some research and calculation a method of determining trace element content in partial mineral separations was worked out. The theoretical solution is simple and involves analyzing the three samples (bulk,

and two partial separations) for major and trace elements and solving a set of simultaneous equations. This method will be published later when enough actual data are available to use as examples.

Methods for Na, K, Mg, Sr are operational and the first 20 samples have been analysed. Rb and Cs will be operational in a few weeks from time of reporting. The analytical portion of the project will be fully operational in a month or so from time of reporting.

I would like to thank the following students for their continuing help in crushing — G. Garven, R. Shirkie and P. Biss, and in mineral separation — B. Peterson.

4. Analytical and Physico Chemical Studies on Herbicides

under the direction of
Professor F. H. A. Rummens

Diallate

As reported previously, we have separated the two (cis- and trans) isomers of Diallate (Avadex) on a preparative basis and assigned the proper structure to each. In co-operation with Dr. A. E. Smith of the Canada Department of Agriculture Research Station at Regina, a bioassay was carried out on the effects of the individual isomers and the mixture (in the commercial 40:60 ratio) on the growth of wild oats. The large number of data were treated by statistical and computer curve fitting techniques (the latter with the assistance of Mrs. D. C. M. Rummens-Ditters). It was established that isomer I is significantly more effective than isomer II; the concentration of I to reduce the average height of wild oat plants to 50 per cent of the untreated plants (H-50) was about 40 per cent less than the H-50 of II. Furthermore, an unmistakeable negative synergistic effect was found; the 40:60 mixture of I and II is less effective than the calculated effect of the sum of the two individual isomers by almost a factor of two. In principle, therefore, a very considerable reduction in pollutant effects could be obtained without any loss to anti-wild oats activity if pure isomer I could be developed.

MCPA and MCPB

MCPA and MCPB are chemical cousins to the well known 2,4-D pesticides. They are in wide use, but little is known about their pollutant side effects. The sole reason for that is the absence of a reliable analysis technique for MCPA and MCPB at the sub-ppm level. We have attempted to chemically modify these acids by esterifying them with halogen-containing alcohols in the hopes of detecting these esters by electron-capture GLC. Our first attempt with mono-chloro ethyl alcohol failed; only a marginal improvement of the signal strength was observed. We have now worked out the chemistry part for two other, more promising, alcohols, viz. trichloro ethanol and penta (benzo) — fluoro-benzyl alcohol. Unfortunately, the project had to be stopped at this point since our electron capture detector has been inoperative for six months, defying all attempts to repair.

Mr. John MacTaggart assisted in this project as a summer (YES) student.

^{19}F Fourier Transform NMR of Herbicides

Much of last year's research effort was spent on optimizing instrument parameters towards improving signal/noise ratio per time unit. This part has been tedious but rewarding; we can say now that, in principle, the measurement of 10 μg (or 10 ppm) of a fluorine-containing sample can be done within reasonable time, i.e., two hours or less.

Some work was done on devising ways to modify the NMR instrument to measure many other elements. In the end it was concluded that the best way to proceed is by purchasing *nuclear packages* specific for each nucleus. It is anticipated that the necessary ^{19}F equipment, worth about $4,000, will be available in the very near future.

COLLEGE OF PHARMACY

1. Culture of Medicinal Plants

under the direction of
Professors N. W. Hamon, K. W. Hindmarsh and D. A. Zuck

Since the Saskatchewan Research Council Grants Committee decided to terminate further support with this their final allocation, for investigating the feasibility of growing Peppermint *Menthos Piperita* in Saskatchewan as another cash crop, it was decided to wind up the study by testing a recommended chemical Herbicide Sinbar® (Terbacil) for weed control and once again compare snow-fencing versus full ploughing to overcome or greatly decrease winter kill.

The plot was divided into four equal parts and these were treated as follows:

First Quadrant — was treated with the herbicide after harvest and ploughed for the winter.

Second Quadrant — was only ploughed — no treatment.

Third Quadrant — was snow-fenced to trap the snow for cover — no treatment.

Fourth Quadrant — was treated with the herbicide and snow-fenced to trap the snow for cover.

In all four quadrants, overwintering was good. Rate of regeneration of plants in spring was faster with the snow-fencing, but the ploughed areas, although slower to regenerate, showed more complete regeneration after a two week lag period.

The use of Sinbar® (Terbacil) drastically reduced weed growth when compared to plots which were left unattended. This led to a thicker and a more healthy stand of peppermint.

The best protection against winter kill is still a six-inch straw cover. Snow fencing will work if there is a heavy early snow fall.

The other details such as fertilizer and irrigation requirements, soil type and its pH, time of harvest have been worked out and are defined in a paper that was published (see reference). Reprints are available.

The authors are willing to share their knowledge gained and their experiences with anyone willing to under-take commercial production of peppermint oil.

Able assistance by Mr. Stan Wolfe, a student, was appreciated during this season.

Publication

N. W. Hamon and D. A. Zuck. Peppermint as a cash crop in Saskatchewan. Can. J. Plant Sci. 52. 837-839, September, 1972.

DEPARTMENT OF SOIL SCIENCE

1. Evaluation of Soil Contamination in the Vicinity of Potash Refineries

under the direction of
Professors J. R. Bettany, D. A. Rennie, A. K. Ballantyne and E. de Jong

The objectives of this study is to monitor and evaluate the effects of accumulation of airborne salts (KCl) from potash refineries on soil productivity and crop growth.

The various activities under this study are summarized below.

1) Soil Benchmark Sampling Program

The soil sampling program was significantly reduced during the year under report; only the six nearest benchmark sites to each of the ten refineries were sampled in the fall of 1973. In the majority of cases, all samples were taken within a one and one-half-mile radius of the refinery. The number of samples requiring analyses has thus been reduced from 1200 to 400. Individual mine area data summaries are prepared annually and distributed to each of the respective potash companies.

2) Crop Monitoring Program

Forage samples (primarily from wheat and barley) were taken adjacent to each of the 12 dustfall monitors located around the ten refineries in June and again in July. Composite soil samples also were taken in July. Both soil and plant samples are presently being prepared for chlorine assay.

3) Field Plot Research Program

The research plots at Langenburg and Laura were again sampled this fall. Soil samples were taken at both sites, but the plant samples were taken only from the Laura plot, wnich was seeded to wheat this year.

The Langenburg field plot may be discontinued, depending on the results of the 1973 soil analyses. The Laura experiment, on the other hand, should be continued for at least another four years. In the latter experiment, the eight-ton/acre KCl treatment gave a noticeable reduction in height of the wheat crop. The yield on the 15-ton/acre treatment was approximately half that of adjacent controls. Grain samples collected from this experiment will be assayed for chloride content.

4) Laboratory Experiments

A series of preliminary laboratory experiments will be initiated this winter. The objectives of these studies is to evaluate, under controlled conditions, the computer simulation equation describing the fate of dustfall (Cl^-) in soils; the simulation equation was developed using the data collected since the initiation of the soil monitoring program seven years ago. A further objective of these laboratory studies is to verify maximum permissible quantities of dustfall (KCl) on soils.

5) Remote Sensing

High altitude (33,000 and 17,000 feet above sea level) imagery was obtained on June 23, 1973 for each of the 10 potash refinery areas. In addition to the standard ERTS package (black and white, IR, red, and green band, and true color obtained using 70 mm cameras) IR color was obtained on a 9 x 9 unit. This imagery provides visual records of crop conditions, hydrology, and soil conditions in the vicinity of each mine area. Prints have been made available to each of the 10 potash refineries.

6) Analysis of the 1964-71 Data Obtained from the Soil Monitoring Program

A systematic analyses and evaluation of the past data obtained in this program has been completed and is available for distribution (see publication below). Significant conclusions that can be drawn from the study include:

a) specific guidelines of the approximate limits (365 kg KCl.hec/year) required to cause serious deterioration and alteration in the physical properties of selected soils;
b) a simulation computer program was developed in which it is possible to predict the fate of chloride falling on selected soils. Further research under controlled conditions is required to ensure that the confidence limits can be considered acceptable;
c) chloride accumulation in the soils surrounding the potash refineries in general followed a circular pattern of approximately 1.5 miles in diameter. In some cases, this area extended out to about three miles in the southwesterly direction. The accumulation of chloride within this area is not serious;
d) movement of natural salts in the soils was clearly evident in the summary data. Throughout the entire potash corridor, indigenous salts in the soil moved upward during the period 1964-1967, while a downward movement of salts predominated during the latter years of the study;
e) the wide range of soil physical chemical properties, including calculated exchange coefficients required to describe the equilibrium between the concentration of cations in the soluble phase and amount present in the absorbed phase is included in a report.

Publication

van Beek, C. G. E. N., Halstead, E. H., Rennie, D. A. and Ballantyne, A. K., 1973. Movement and accumulation of salts in soils around potasium refineries in Saskatchewan. S.I.P. pub R127. pp. 199.

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RESEARCH
COUNCIL

THE SASKATCHEWAN RESEARCH COUNCIL

FINANCIAL STATEMENT

Year Ended March 31, 1973

To the Directors of
The Saskatchewan Research Council

AUDITOR'S REPORT

Pursuant to Section 20 of The Research Council Act, being Chapter 406, Revised Statutes of Saskatchewan, 1965, I have examined the balance sheet of The Saskatchewan Research Council as at March 31, 1973, and the statement of equity in fixed assets and the statement of operations and operating surplus for the year then ended. My examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as I considered necessary in the circumstances.

I am unable to verify unbilled shareable costs reported under that caption on the balance sheet as the Federal-Provincial cost sharing agreement for the fiscal period April 1, 1972 to March 31, 1974 has not been executed to the date of this report.

In my opinion, subject to any adjustments to unbilled shareable costs and operating surplus which may occur after the agreement has been executed, these financial statements present fairly the financial position of the council as at March 31, 1973 and the results of its operations for the year then ended, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Regina, Saskatchewan,
November 23, 1973.

W. G. Lutz, C.A.,
Provincial Auditor.

NOTES TO FINANCIAL STATEMENTS
March 31, 1973

1. Fixed Assets:

The Council's policies are:

1. To record in the fixed asset accounts all equipment with cost of $50 or more acquired during the year.

2. To remove from the fixed asset accounts all equipment which has:

— become obsolete during the year
— been sold during the year
— been in service for 10 years.

2. Unbilled shareable costs:

Under the terms of a two year agreement with the federal government agency administering the Agricultural Rehabilitation Development Act, the Council has incurred eligible expenditures of approximately $400,000 which are included in Statement 4 (Statement of Expenditures).

The agreement allows the Council to recover from the federal government agency one-half of all eligible expenditures.

3. Comparative figures:

Figures for the previous year have been restated in order to make the financial statements comparative.

Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1973

(with comparative figures at March 31, 1972)

ASSETS

	1973	1972
Current:		
Cash	$ 99,713	$ 4,873
Guaranteed savings deposit — 4½%	144,034	112,358
Accounts receivable	93,381	189,181
Unbilled shareable costs (Note 2)	200,000	—
Prepaid expenses and deposits	9,985	11,663
Total current assets	$ 547,113	$ 318,075
Investments — Cost	$ 60,000	$ 60,000
Fixed — Cost (Note 1)		
Laboratory equipment	$ 558,995	$ 535,443
Automotive equipment	107,681	84,877
Building	81,000	81,000
Furniture and fixtures	78,465	66,118
Shop equipment	46,169	46,168
Land	10,000	10,000
	$ 882,310	$ 823,606
	$1,489,423	$1,201,681

LIABILITIES AND EQUITY

	1973	1972
Current:		
Accounts payable	$ 72,510	$ 86,016
Employee deductions payable	37,018	10,432
Advance from Provincial Treasurer	175,000	—
Total current liabilities	$ 284,528	$ 96,448
Equity:		
Equity in fixed assets (Statement 2)	$ 882,310	$ 823,606
Operating surplus (Statement 3)	322,585	281,627
	$1,204,895	$1,105,233
	$1,489,423	$1,201,681

(see accompanying notes to financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1973

(with comparative figures for the year 1972)

	1973	1972
Equity in fixed assets, beginning of year	$823,606	$851,638
ADD:		
Fixed asset additions (Statement 4)	66,650	106,779
	$890,256	$958,417
DEDUCT:		
Fixed asset disposals		
— written off (Note 1)	$ 437	$125,172
— sold	7,509	9,639
	$ 7,946	$134,811
Equity in fixed assets, end of year	$882,310	$823,606

(see accompanying notes to financial statements)

Statement 3

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF OPERATIONS AND OPERATING SURPLUS

Year Ended March 31, 1973

(with comparative figures for the year 1972)

	1973	1972
Revenue:		
Cost sharing arrangements and grants		
— Province of Saskatchewan	$1,495,843	$1,182,102
— Government of Canada	453,100	505,469
— Industry	141,267	139,333
	$2,090,210	$1,826,904
Fees for services	91,903	60,324
Investment income	14,983	13,732
Proceeds on disposal of fixed assets	4,732	5,255
Other income	1,977	1,831
Total Revenue	$2,203,805	$1,908,046
Expenditures: (Statement 4)	$2,093,327	$1,766,912
Research grants (Statement 5)	69,520	73,135
	$2,162,847	$1,840,047
Surplus	$ 40,958	$ 67,999
Operating surplus, beginning of year	281,627	213,628
Operating surplus, end of year	$ 322,585	$ 281,627

(see accompanying notes to financial statements)

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1973

(with comparative figures for the year 1972)

	Admin.	Chem.	Eng.	Geology	Industrial Services	Physics	1973 Total	1972 Total
Employee benefits	$ 7,891	$ 11,969	$ 13,038	$ 11,537	$ 5,192	$ 6,658	$ 56,285	$ 42,355
Fixed asset purchases	9,381	6,294	13,574	24,217	1,062	12,122	66,650	106,779
Other	48,986	9,844	33,471	70,448	13,835	10,975	187,559	197,468
Salaries	115,062	222,222	339,540	228,689	104,049	169,197	1,178,759	976,374
Supplies	12,712	8,851	43,879	12,934	14,218	16,673	109,267	107,970
Technical services	19,481	4,090	71,296	303,172	1,006	24,097	423,142	274,610
Travel and vehicle operation	10,936	3,396	15,559	27,386	8,595	5,793	71,665	61,356
	$224,449	$266,666	$530,357	$678,383	$147,957	$245,515	$2,093,327	$1,766,912

(see accompanying notes to financial statements)

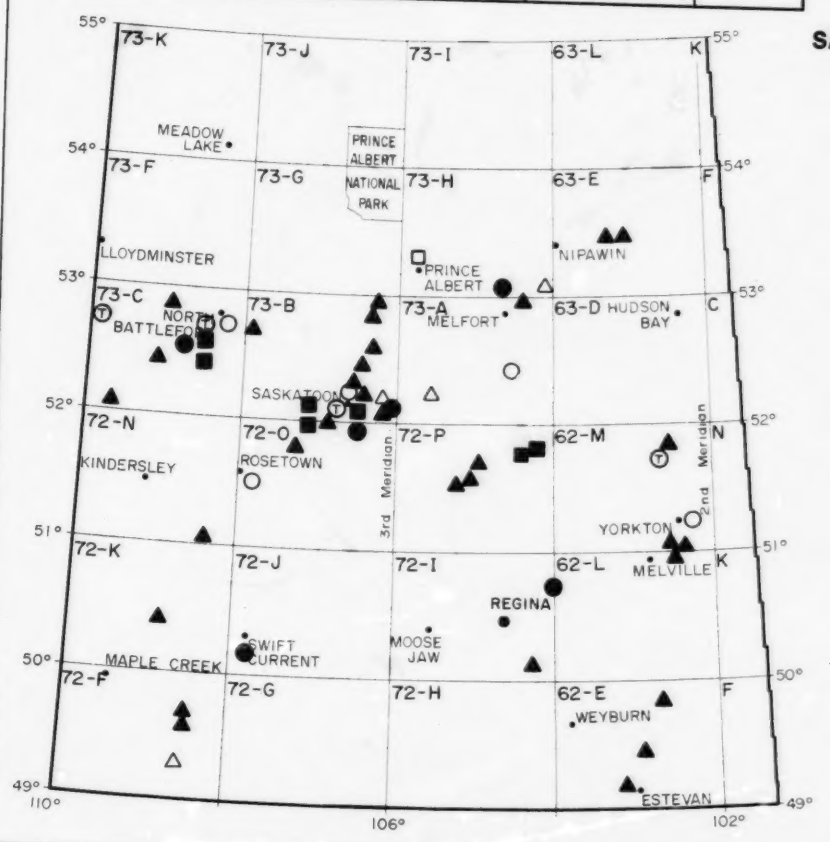
THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF GRANTS FOR RESEARCH PROJECTS

Year Ended March 31, 1973

(with comparative figures for the year 1972)

	1973	1972
Petrology and Structure of Anhydrite Beds	—	$ 333
Pea Protein as a Protein Source	$ 3,193	2,795
The Culture of Medicinal Plants	3,975	3,625
Sedimentary Strata of the Prairies	900	883
Helium-4 Mass Spectrometry for Uranium Exploration	1,330	1,958
Pollution of Soil, Water, etc. by Pesticide	4,000	4,000
Photochemical Degradation of Pesticides, etc.	3,000	4,000
Hydrogen Reduction of Sodium Sulphate	3,382	3,281
Studies of Microseismic Energy Emission	4,000	5,000
Genetic Aspects of the Flin Flon Ore Body	3,000	3,500
Irrigation and Fertilizer Studies — Vegetable Crops	3,298	3,129
Soil Contamination from Potash Refineries	14,047	23,153
Research in Fluid-Solids Systems	3,500	3,500
Structural Geology of Saskatchewan	—	1,250
Stratigraphic Studies in Cretaceous Rocks	3,000	3,200
Algae Cultured in or upon Saskatchewan Lakes	2,991	5,400
Production of Pure Inorganic Salts	3,472	2,528
Structure Determination of Diallate Herbicide Isomers	1,600	1,600
Chemical Analysis of Birch Bark	1,657	—
Study of Foundation Conditions in Downtown Area of Saskatoon	2,300	—
Proterozoic Archean Contact in the vicinity of Hanson Lake Road	4,000	—
Remote - Sensing of Moisture Stress	2,763	—
Genetical Control of Mosquito	112	—
	$69,520	$73,135



LOCATION OF SASKATCHEWAN RESEARCH COUNCIL FACILITIES

EXPLANATION

- ▲ Observation well
- □ Topoclimatological station
- ○ Pesticide sampling site
- △ Spray freezing site
- ● Slough study
- Ⓣ Tritium study
- ■ Watershed